Library Trends

Mechanization in Libraries

ARNOLD H. TROTIER, *Issue Editor*

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Library Trends

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LIBRARY TRENDS, a quarterly journal in librarianship, provides a medium for evaluative recapitulation of current thought and practice, searching for those ideas and procedures which hold the greatest potentialities for the future.

Each issue is concerned with one aspect of librarianship. Each is planned with the assistance of an invited advisory editor. All articles are by invitation. Suggestions for future issues are welcomed and should be sent to the Managing Editor.

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CONTRIBUTORS TO THIS ISSUE:

Introduction

ARNOLD H. TROTIER

THIS ISSUE of *Library Trends* is an attempt to bring together for the first time in one place information on the application of machines to the performance of library operations and techniques.

Strictly speaking, mechanization in libraries relates to the replacing of personnel engaged in library operations with machinery wherever possible. Although the articles in this issue give considerable attention to this particular aspect of the subject, they are broadly concerned with the application of machinery, appliances, equipment, and tools to various library operations for the purpose of making these operations possible, better or easier.

Melvin Voigt's introductory article lays the foundation for the rest of the issue insofar as it discusses the nature and principles of mechanization in libraries and the application of these principles to library operations in general. His paper, among other things, examines such questions as the following: (1) What are the underlying reasons for introducing machines into libraries? (2) To what kind of repetitive operations do they lend themselves? (3) What factors have either promoted or hindered their use in libraries? (4) What effects have they had on library operations and services? (5) What are the attitudes toward them of library administrators and staff? (6) Does automation offer any possibilities in the foreseeable future with respect to any major library operations?

Each of the succeeding articles relates to a particular type or kind of machine, appliance, equipment or tool utilized, or potentially useful, in library operations. Some of these devices were designed for use in business and industry in general and were adopted by libraries without change; others were adapted, in some instances to a considerable degree, to meet special library requirements; still others were especially designed to perform operations peculiar to libraries. With

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respect to the devices assigned to them, the contributors, in general, review the development of the use of these devices in libraries, assess their current use and value in the mechanization of library procedures, and, on the basis of apparent current trends, attempt to predict what future developments may be anticipated in this area.

Some librarians have expressed the opinion to the writer that, compared with business and industry, libraries have been quite conservative with respect to the use of machines, that they have often been laggard about adapting mechanical aids to library operations, and that they have contributed little towards the developing of machines designed especially for library applications. The facts produced in the papers published in this number tend to show that, at most, these judgments are only partly true. There is a great deal of evidence that libraries have taken advantage of the technological progress witnessed by this generation. Many of our fellow librarians have applied and adapted mechanical aids to library procedures with notable success. Some have stimulated and prompted manufacturers to develop and build equipment to serve the special requirements of libraries. And a few have combined rare imagination and exceptional inventive and mechanical ability with an intimate knowledge of library techniques and management to conceive new machines for the performance of operations peculiar to libraries.

If librarians have made significant progress in recent years in the direction of mechanization of library operations, it has been not only because more machines and appliances suited to library applications have been available, but because increasing costs of library services have focused attention on ways and means whereby these services could be carried on at costs they could afford to pay, and also because the growing problem of maintaining the staff required for accomplishing the essential functions of the library necessitated the substitution of machines for personnel wherever possible.

Mechanization of operations is part and parcel of scientific management. And scientific management is relatively as important in libraries as it is in business and industry generally. The need for it has always existed, but has become increasingly important in recent decades as a concomitant of the rapid growth of libraries and the greatly expanded demands for library services. It is to be hoped that the articles presented here will not only supply useful information on the subject, but that they will stimulate ideas and experiments which will provide further impetus to the trend towards mechanization of library operations and the improvement of library service in general.

The Trend Toward Mechanization in Libraries

MELVIN J. VOIGT

THE CONCEPT OF MECHANIZATION, whether applied to libraries and library operations or to any other aspect of human endeavor, requires definition, or, more important, limitation, before the trend toward its utilization can be discussed intelligently.

In broadest terms any operation not performed by the human mind may be considered to be mechanized, and even mental processes are considered mechanical when analyzed in terms of what has become known as cybernetics. In a sense, the act of putting a book on a shelf, or taking it off, is a mechanical operation. The book itself is a mechanical device for storing information. Indexes and card catalogs are mechanical tools for retrieving stored information.

A narrower, more common concept of mechanization is one which relates it to any operation or device which uses a machine. Here one aspect of the physicist's definition of a machine, a device which gives mechanical advantage, is useful. This concept implies force or motion. Thus the use of a wheel, as in a book truck, may be considered mechanization while a book rest, also a mechanical device, is not. Many of the mechanical tools or gadgets used by libraries would fit into this concept.

Since the advent of the word automation and its popularization by over-enthusiastic reporters, there has been a tendency to confuse the words mechanization and automation and to use them synonymously. A discussion of mechanization today must give some attention to automation, but automation is a device for achieving a certain degree or level of mechanization, not its counterpart. Strictly speaking automation describes a self-regulatory operation in which the control, achieved by what is known as feedback, keeps the process going within certain desired bounds or levels. The two classic examples of

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this are the steam engine governor in which the output, acting by means of centrifugal force on rotating flyballs, controls the input and the household thermostat which controls the temperature of the room by turning the furnace off and on, keeping the degree of warmth within certain narrow limits at all times, regardless of the amount of heat escaping to the outside.

Automation is also used in a broader sense to describe non-continuous operations consisting of a series of smaller jobs which are performed in sequence without human control. Automation is used loosely in a third sense as the technological development involving computer machines which are capable of performing simple and complex mathematical operations on information, usually in binary form, which the machine can record and store. A discussion of the trend toward mechanization in libraries must go beyond automation and cover the use of machines of all types, even if it arbitrarily passes over the broader concept that all non-intellectual operations or devices are aspects of mechanization.

While new machines may accelerate the trend toward the application of things mechanical in libraries, the trend is not new nor even recent. American librarianship, if one uses the content of its early publications as a guide, was interested in mechanization from the beginning; indeed one might suggest that one of the purposes early leaders had in mind in founding the American Library Association was to facilitate the exchange of information on the application of processes or products of the machine age which might be useful in library practice. The early literature of librarianship both in this country and elsewhere is full of information on mechanical devices. Library conferences, it seems, have always included exhibits of equipment. Some of the devices exhibited at early conferences have now become so common that we would hardly think of applying the term mechanization to their use. Others have no more value today than do the mechanical hat tipping patents reposing in patent files. The indicators which flourished for many years in British libraries to advise the user and librarian which books were not on the shelves have long been forgotten.

The typewriter, which would probably receive most librarians' votes today as the library's most essential machine, early caught the librarian's fancy. At the second annual conference of American librarians at New York, in 1877, Melvil Dewey reported that he had received a communication from J. C. Rowell at the University of California stating, "I have been thinking of introducing in our library

the type-writing machine, for use in cataloguing."[1] The A.L.A. president, Justin Winsor, did not approve of the work done by this machine but others were more interested in it and other mechanical gadgets.

There have always been some who deplored the use of mechanical devices in libraries. The case for these doubters was caustically put by J. Y. W. MacAlister at the second International Library Conference in London in 1897.

> My critics will tell you that the more time-saving apparatus is used the more time the librarian will have to cultivate his intellect and discourse with his readers on the beauties of Browning or of Byron. But is the time saved by mechanism used in this excellent way? I am afraid not. The taste for such things grows on what it feeds, and the librarian who has invented an appliance for supplying his readers with books (they would rather not have) by means of an automatic ticket-in-the-slot machine will not be happy, or spend any time in reading Browning, until he has invented one which will, by the touching of a button, shoot the book into the reader's home. . . . If a new machine comes to be wanted very badly, it will be produced; but let us wait for an imperative demand, instead of cogitating how we can, by clipping off the corner of a card, or sticking in a new pin, or even by calling an old spade an agricultural implement, secure fame for ourselves as original inventors.[2]

Now it is possible for libraries to "shoot the book into the reader's home" by means of facsimile reproduction and librarians clip and stick pins in new ways with their punched cards. The question of whether they have waited "for an imperative demand" or whether they are looking for fame as inventors is probably not very important. The librarian's philosophy from the beginning has been to accept and adapt for library use whatever mechanical devices fit his needs, regardless of what their use might be outside of the library. If one divides the machines used in libraries into three groups, those which have been adopted with little or no change, those which have been adapted to a considerable degree before being put to use in libraries, and those invented or designed originally for libraries, it is evident that librarians have been opportunists, not inventors.

A typewriter or a mimeograph could be put to use in a library without any change. Even conveyors and pneumatic tubes could be removed from department stores and put into operation in a library stack with little change. It took only a little mechanical know-how

to convert the mechanical operation of a time clock into a charging machine.

As machines have become more complicated, have been designed more for a single, specialized use, it has been necessary to do more adapting and even to engage in invention if the library was to keep up with the mechanical revolution. And, as might be pointed out to MacAlister, it has not been just a matter of keeping up. Librarians, with more books, with more users, with increased costs, have found it necessary to grasp for any kind of assistance, and when a mechanical device gave promise it was tried.

The profession is fortunate to have a few librarians with sparks of inventive genius. First among these is R. R. Shaw. It took more mechanical and inventive ability than most librarians possess, together with an intimate knowledge of library processes, to put well-known photographic processes to work in the photocharger and the photoclerk, and in pushing forward an intricate idea like the rapid selector. To the imaginative popular writer it is only a step from information theory, basic to computer design and operation, to information storage, in terms of information as found in books. While digital computers are likely to become important in some aspects of librarianship, the adaptation of these machines, whether to ordinary library operations, or to the storage of information in the form of words, sentences and books, presents problems technologists are not ready to cope with. Yet, the librarian's greatest interest in machines today is in their possible usefulness for the storage and location of information and even at this early date, an historical study of mechanization in libraries should point out that the trend is toward their use whenever it can be made practical.

Mechanization is regularly cited as one of the devices of scientific management and the trend toward mechanization goes hand-in-hand with the trend toward the application of principles of management. The most efficient combination of men and machines to accomplish the task at hand is the goal of the management expert. This concept is as applicable to library management as to any other enterprise. To the management expert, many library operations seem, at first glance, to provide the ideal kind of operation for wholesale replacement of men by machines. The librarian deals in large quantities of materials, circulates books by the hundred thousand, buys and catalogs them by the ten thousand, stores them by the million, produces and files cards in fantastic numbers. Where quantity is involved, mechanization can take over, the management expert says, and where opera-

tions repeat themselves day by day and week by week, automation should cut down the needs for manpower even more. And it would seem so, for automation is moving rapidly into office procedures, often where the numbers of transactions are less than in libraries. Although library tasks are repetitive, they are not identical. The librarian's approach to mechanization must be governed by this fact. The management survey of the Preparation Division of the New York Public Library's Reference Department pointed this out in the first chapter of its report.

> To the management analyst accustomed to the office routines and production techniques of business and industry, the preparation machinery of a large research library presents both a challenge and a fascinating field for study. Here one finds the customary exterior of a mass production office operation—files, forms, typewriters, and controls. But there the similarity largely disappears and a complexity complicated by strange terminology is encountered in almost every phase of the work. The concept of repetitive operation which is the keynote of economical mass production in business is strikingly absent in the Library because each new piece prepared may present new or unusual problems to the searcher, the cataloger, the filer and other assistants. In this respect, preparation exhibits characteristics more closely allied to those involved in manufacturing a custom-made product. As one becomes more intimately acquainted with the substance of cataloging, it is more readily apparent that preparation is not a series of simple clerical tasks but a professional undertaking requiring skills that only specialized training and experience provide.[3]

Librarians are quite aware that similar conclusions would be reached if studies were made of many other aspects of library work.

Mechanization has always been related to division of labor and it is true in libraries, as elsewhere, that mechanization becomes increasingly possible where work can be dissected into component operations. Adam Smith in 1776 stated, ". . . the invention of all those machines by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour."[4] Library managers early saw the advantages and possibilities of division of labor. By applying this principle they were better able to utilize those machines which require constant use to make them economical and whose efficiency is increased by using skilled workers who spend all or most of their time in their operation.

Library operations are divided and they are repetitive—books are cataloged, books are obtained from the stack for readers, reference

questions are answered. In cataloging, each book goes through a process similar to that for every other book. An entry is chosen, the book is described, subject headings are assigned, the book is classified. But few books receive the same entry, every description is different. Even a machine which would automatically transfer information from a title page to a card would not save the cataloger very much time. As long as cataloging or any other process remains largely an intellectual operation it will not be susceptible to a high degree of mechanization. Donald Coney[5] has pointed out that although library work is replete with drudgery, it is not repititious in ways acceptable to the machine.

It may be that there will be changes in cataloging procedures which will make them more mechanical, in the broad sense of the term. The uniterm indexing process makes subject indexing more of a clerical operation than traditional subject cataloging. Any use of computers, whether to provide information or to help locate desired printed material would make certain aspects of reference work more mechanical. However, unless processes now generally used are radically changed, there is little in current library trends which makes it seem likely that management will be able to mechanize those library operations, typified by cataloging and reference work, to a much greater degree than they are now mechanized. If the processes themselves can be changed, can, for example, be substituted for by cooperative undertakings made possible by new developments in communication, some of these processes will be changed or even eliminated.

Many operations in libraries have been improved, speeded up, reduced in cost, or simplified by the use of mechanical devices. Unfortunately, these devices are often too expensive for the smaller or average size library. Most libraries do not have enough work of the kind done by these machines to justify them. While the large university library may be able to speed up cataloging and reduce the cost of producing catalog cards by substituting a Xerox-multilith process for the ordering and purchase of cards from the Library of Congress, the college library which wants the same amount of bibliographical detail on its catalog cards will find it more economical to continue ordering its cards from L.C. Even the photoclerk which has been shown to have possibilities for effective use in medium-sized as well as large libraries may be economically unfeasible in most of the smaller libraries in the country.

J. R. Bright,[6] in discussing automation, suggests that it is a relative, not an absolute, concept. He goes on to postulate seventeen levels of

mechanization or degrees of mechanical achievement. His view that optimum levels of mechanization vary with different enterprises and that management's goal should be the most economical level of mechanization is a basic principle for libraries.

The problems of determining when a machine should take over a repetitive job which it can do are often too difficult for librarians to solve. The principles may be quite clear but an attempt to determine whether the machine will do a job cheaper and better may introduce so many variables and unknowns that the librarian has neither the time nor the tools to make the necessary measurements. L. N. Ridenour warns librarians that, "The problems of a library are, for the most part, unique to a library. They should be attacked only by persons who are willing to view them as being unique, and to prescribe for them in uniquely suitable terms. There is no reason to think that machines or methods designed to serve other purposes will be of much direct use to the librarian." [7]

The application of scientific management is clearly not synonymous with the adoption of machines for every library process or procedure. Herbert Goldhor [8] in speaking of scientific management states that public libraries have moved a long way in mechanization and that they are probably still far from seeing the end. He warns: "But it would be a serious mistake to think of mechanization first or uncritically. Machines are expensive to purchase and often to operate and maintain; their obsolesence and depreciation tend to be higher than we realize; for best results they demand more severe standardization than we are yet prepared to make; their very installation tends to perpetuate a process that might otherwise be even more drastically modified or completely eliminated. . . ."

Any machine method, once adopted, is difficult to drop. It is easy to see that a book conveyor, once installed, is difficult to change or discard. But any procedures or patterns of work, once adopted and put into practice, become fixtures. The use of machines must be planned in terms of over-all objectives and needs, not in terms of what the machine can do or even what manual process the machine can replace.

Before management decides to mechanize an operation certain questions must be asked. Does it improve quality and quantity? Does it improve accuracy? Does it provide services otherwise unavailable? Does it reduce costs? Does it make better use of manpower? While the answers to all of these questions may not be in the affirmative an additional question certainly must be: Does it achieve the desired objective? Reaching over-all objectives, not mechanizing indi-

vidual processes, must be the guiding principle in library management.

Little has been said thus far about mechanization of information storage. Librarians are probably too close to this topic to discuss it adequately. Twenty or thirty years from now *Library Trends* can treat it with historical perspective and possibly predict with confidence the effect it will have on libraries. One could take the evidence available today and state categorically that there is no mechanical device at hand or foreseeable which will replace the book as a means of storing information and of making it generally available. Yet, as Shaw has stated, ". . . it would be well not to underestimate the potential of technology . . . whatever one man can dream, sooner or later another man can build."[9]

The most important application of mechanization to information storage today is the microform. More than anything that can be predicted today, it has assisted and will continue to assist libraries in dealing with one of their greatest problems, size and space. Microtext, whether it be film, card, print, or sheet, cannot be underestimated in its importance to libraries. Yet, while its prevalence and use cannot help but increase in coming years, librarians keep looking over their shoulders, hoping for something better. By this time they have learned to live with these microforms and in larger libraries and library cooperative ventures they could hardly hope to operate without them. For compact storage, for cost, compared to their book counterparts, for their possibilities in making unique or rare material which may exist in only one place available anywhere, these machine products are unexcelled. For ease of use, for speed in producing a wanted piece of information, for availability for constant or heavy use, microforms are deficient; and it is difficult to imagine a library of the future made up of nothing but microfilm or microcards.

The term information storage, however, has not been used generally to mean microform storage. Instead, imaginations leap at the idea of "giant brains" holding all of the information in a Library of Congress and telling every user just what he wants to know at the touch of a push button. In the last few years a good many holes have been pricked in the fanciful balloons dreamed up by those who would replace the library with a machine. The essence of these arguments is that regardless of how well a machine can store information and in how little space, it is of little value unless it is possible to put information in the machine easily and efficiently, and, more important, retrieve it in usable form just as easily.

The fact that computers are not designed for handling alphabetic

material creates difficult problems and places limits on their ultimate use in information storage. This fact makes codes, which can be converted to binary form and mechanically reconverted, essential. Important work has been done on coding and classification, particularly in the specialized area of coding of chemical compounds. It is unfortunate that there has not been greater clarification of what is needed to put information in forms acceptable to machines. One gets the impression that the muddied waters are being kept stirred up by well-intentioned persons whose seemingly profound observations offer little that is applicable. Perhaps a period of blind groping is not harmful, but it would be helpful if some of the papers and discussions would be correctly labeled as such instead of being set forth as significant developments.

The problem of input and output is far from a solution but the question of replacing books with computers goes beyond this. A book is an ideal source of information because, unlike a machine, it can be used without predicting or programming the pattern of use. Using content pages, indexes, and an ability to pass quickly over hundreds of pages of irrelevant material, the user turns directly to what he wants or moves rapidly back and forth among the pages until he is satisfied that the book has supplied all it can contribute to his needs. Searching for information in books is largely an intellectual operation requiring that judgments be made in the course of the search. The computer on the other hand, must be set at the beginning to follow through a programmed, linear sequence, "reading" through every bit of information in every page or volume, passing over what may be relevant unless set to catch it through a specific word or series of words.

When one passes from the idea of storing information in machines to the possibilities of using machines as a means of locating information within books or other printed materials, the prospects look better. There are practical limitations here, too. To use machines to lead the user to the *World Almanac*, or the *Encyclopædia Britannica*, or even to Barlow's *Tables of Squares* or to information stored in any of the thousands of reference works which are quickly and easily available to every user of a general reference collection, would not save time even if economically feasible. Only when reference searches are approached as complicated as one typified by a search in *Chemical Abstracts* for all relevant material on the specialized applications of a method of chemical synthesis, does machine searching appear to become attractive in terms of time, cost, and completeness of the

answer. The larger and more complex *Chemical Abstracts* or any other literature service becomes, the more attractive this possibility appears. At present, only in fields where there are great quantities of material without adequate printed bibliographical controls does the machine seem essential. There are two good examples of areas where this problem has become critical. In the field of patents a serious search is underway to find methods of applying machines to patent operations. The second critical field is that of unpublished technical reports. In the patent problem the attempt at solution is an over-all attack, where the machine seems to offer the only solution. In the second case, no over-all control has been achieved or attempted, but, because of the wide variety of sources and uses, fairly satisfactory solutions have been devised to give partial control. Traditional indexing methods are used by some of the governmental and military agencies, while a new mechanical (if not machine) indexing procedure, coordinate indexing, is used by other agencies. Experiments indicate that the uniterm coordinate index can be adapted to machine use and that for this type of index the digital computer can be put to practical use in locating printed material.

In discussing the possibilities of mechanizing approaches to printed material one tends to think in terms of the sciences and engineering. There is considerable evidence that the degree of bibliographical control in some other fields is also critical. Scholars in the humanities and in the social sciences have never had a means of approaching source materials which would reasonably insure their locating all of the important information on a topic. Perhaps they have not needed this kind of an approach. Certainly they have not had the economic support of industry and government which has made it possible in scientific fields. The problems involved in the historian's search for material in manuscript and archives collections, for example, appear to be as complicated as those of the scientist. With problems quite different from those faced by the scientist, it is possible that lack of demand and of economic support may delay the trend toward the use of machines to aid the user of printed materials in these fields.

In discussing automation, the question should be asked whether automation has been or can be applied to mechanical devices now used or likely to be used in the library. For most of the machine operations now carried on in libraries, the answer appears to be negative. The problem again is one of uniqueness and judgment. Certain mechanical devices such as book conveyors make use of automata, or might profitably do so. It would be possible to make almost any

part of the lending process automatic. The presentation of the call slip, the annunciator which gives notice of the book's arrival at the desk, the charging process, the sending of the overdue notice, all of these, even to taking the book off the shelf, could be mechanized using principles and applications of automation. Perhaps some of the simpler operations will be, but in terms of cost and service the loan operation seems to offer little real hope as the library's version of the "automatic factory."

Where libraries use punched cards extensively, most often in circulation and order activities, a degree of automatic control can be achieved. However, most of the machines libraries now use seem to offer little opportunity for automation. Only if generally accepted concepts of library practices are radically changed so as to bring in new ways of providing information for library users, does there seem to be any possibility for large-scale automation in the library. If a large scale computer were available for part-time use in a large library it might be used effectively for the bookkeeping operation of an order department with its hundreds of book accounts. With a computer available, the catalog presents a tantalizing possibility. If a coordinate index can be put in a machine, why not a library's card catalog? The catalog is the library's most expensive tool and while further mechanization of the catalog process may not be feasible, the resultant catalog might be put on a magnetic drum or tape. Ease of access and speed of retrieval of information in usable form again appear to be problems. Shaw states it this way, "An electronic machine which can digest five hundred thousand, or even five million, digits per second, does not necessarily answer more questions faster or cheaper than a card catalog which stands still and permits hundreds of humans to walk slowly about it." [10]

For some time to come, most librarians when they want to point out an example of automation at work in their libraries, will be forced to point to the thermostat on the wall or to the sprinkler system they would rather do without.

It has been noted that operations which require many varied judgments cannot be handled economically by automata and are not likely to be replaced by fully automatic processes, and that often such operations have not lent themselves to any type of mechanization. However, as R. L. Meier [11] points out in a recent article, such operations may be changed by modern communication developments which are part and parcel of mechanization and automation. If any development is to make the library, or some library, or part of a library,

superfluous in the foreseeable future, it is communication. Communication over distances—from one building to another, or across a country—whether through facsimile reproduction or by some other device, should make the contents of any library available to users anywhere within a country or any large area. But even this development, brought within practical economic limits, would not decrease the need for libraries. However, simplification of communication over distances should have an important effect on such library operations as cataloging and reference work. Through centralization and cooperation, the necessity of locally producing expensive bibliographical tools may be reduced. Subject bibliographies, far superior to those available in any one library, could be available for consultation many miles away, or a list of sources could be produced for the user at any location. The local library might then need only a simple finding list to show which items were available and their location. Processing costs make librarians take a second look at this possibility. The applications of this approach to reference service is also obvious. If librarians do nothing else they should be able to furnish bibliographical and other information to any library as needed from a central location. After a book has been cataloged once, the "card" could be made available for copying by any other library. Perhaps the required number of cards could be produced automatically through television-type transmission and an automatic printer. In the larger research libraries even a small percentage reduction in the total cost of cataloging would support a fairly elaborate system.

While the book lover may rest assured that the "automatic library" is only a distant mirage, it is clear that mechanization in libraries has not reached its limits. While the degree of expansion of mechanical operations possible in libraries appears to be related closely to size, there will be new machines to fit certain needs of every library. The largest libraries will continue to make the greatest use of machines because the quantity of work to be done and the degree of specialization possible in a large organization will make the adaptation of expensive new products and developments economically feasible.

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Library Communication Systems

SCOTT ADAMS

Communication, in the mechanistic sense connoted by this issue, may be broadly defined as the technology of conveying information. This broad definition would include the library itself, which, as a social institution, is a technical instrument for the transfer of information.

This paper, however, is concerned with but one aspect of the communication complex: the application of communication technology to certain library functions, namely:

1. Conveyance of administrative information (i.e. that controlling library services and traffic.)
2. Conveyance of information derived from the library's resources (i.e. reference work in its many forms.)
3. Conveyance of information recorded in the resources themselves (i.e. the lending of materials.)

Definitions are always arbitrary, and despite the fact that logic should prevail, discussion of the following communication techniques has been excluded from this paper: pneumatic tubes, microfilm, radio, and television. These are discussed elsewhere in this issue. The audio-visual media are immensely important in today's world, and have worked to condition the library's role as an instrument of mass communication. The communication systems to be described in this paper, while they relate to basic library functions, have received less attention in the professional literature.

Communication is a function of complexity; the larger the institution or the library system and the more complex its activities, the greater the need for administrative communication. In this the library is one with industry, commerce, and government. Information must be collected for decisions; decisions must be communicated; questions must be asked and answered, instructions given and received. Libraries have usually borrowed communication devices and systems, there-

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fore, from the business world. Here, new devices and suggested applications are frequently reported in such periodicals as *Management Methods* and *Systems,* and the librarian interested in systems developed would be well advised to follow them.

Among the oldest devices for vocal communication is, of course, the telephone. It is interesting to speculate how much American libraries owe their development to this instrument. Certainly they have come a long way since the innovation of telephone reference service in the St. Louis Public Library so overburdened the exchange that the operators refused to handle library calls.[1] The use of telephone systems for external and internal communication is now axiomatic.

There are, in addition, special telephone system adaptations, some of which libraries have used successfully, for internal communication. For example, the Bell Telephone System offers a "dial intercom" arrangement for standard instruments. Intercom systems, or two-way private telephone lines fitted either with conventional handsets or with speaker and microphone desk sets, exist primarily for the purpose of enabling an administrator to consult with his staff, either singly or in conference. Intercoms have become increasingly popular both in newly planned libraries, and in remodelled buildings.

The physical size of the building, the complexity of the library's functions, the size and the organizational pattern of its staff appear to be the principal factors determining the decision to install an intercom. The Brooklyn Public Library reports not only a private intercommunication system of telephones in its Central Service, but also its intention to install an intramural dial system for the whole building.[2] The Armed Forces Medical Library has planned two intercom systems for its new building, one with nine stations for administrative control, and one with ten for circulation desk to stack communications.[3] Such intercommunication between the circulation desk and stacks appears to be a less common application than the administrative one. In a closed-stack library, despite the advantages enjoyed by graphic communication, a vocal intercom system offers much to speed service.

Telephone answering services (familiar to all who dial for the weather report) and telephone message recorders, both available through the Bell System, would have limited application in special library situations; the literature discloses no evidence of their use.

Public address systems or paging devices, for obvious reasons, have been less popular with libraries than intercoms. Commonly, these are one-way systems using a microphone, amplifier, and one or more speakers. Possible library applications include communication between

the circulation desk and closed stacks (analogous to the sales-counter-to-stockroom communication of business), and public paging. A few specialized libraries in hospitals or medical centers, where such public address system installations are common, take advantage of them to communicate with readers.

An interesting device now used in hospital situations is the vest pocket radio, the "Pagemaster", produced by Electronic Systems Control, Los Angeles, California. A receiver, tuned in to a predetermined wave length, is charged out to the doctor. When the switchboard operator dials the number of the receiver, a radio signal activates a buzzer in the receiver, and its owner goes to the nearest phone to receive the message.

In distinction to the above audio systems, the Telautograph provides the receiver with a graphic record. This system permits the writing of a message on a continuous roll paper form in a transmitter and its simultaneous reception in facsimile form on one or more receivers. It has been installed in a number of libraries for intercommunication between the circulation desk and the stacks. It has, of course, the obvious advantage of providing an accurate graphic record of the information communicated: the call number of a book, citation in a periodical, or report of a search. TelAutograph has one advantage, reception is automatic, and messages may accumulate to be collected at convenience.

A handwritten communication system has advantages where there is dependence on a central library record. Thus, at the John Crerar Library, TelAutograph is used to send information from the shelflist to service points. The efficiency of the telautograph with pneumatic tube communication is compared in the article on transportation equipment. The equipment is leased, rather than sold; information is available from TelAutograph Corp., 1128 Crenshaw Blvd., Los Angeles, California.

Annunciators are visible signalling devices used to notify patrons of large closed-stack libraries that the material requested, or information relating to it, is available. Serial numbers corresponding to a seat number or a ticket are flashed on a large panel located over the circulation desk. The system is analogous to the visual paging devices used for doctors in many hospitals. That in the Reference Department of the New York Public Library is, of course, the classic example. It was locally constructed by staff electricians. The Butler Library at Columbia University offers an example of a more modern installation.

Closed-system or industrial television apparently has not yet been

used in library situations. Early in 1952 the Library of Congress experimented briefly with ITV for reference and verification; an L.C. card or a bibliographical reference could be scanned in one area and viewed in another.[4] Where a permanent copy is not needed, ITV offers distinct possibilities in conveying information. The use of ITV by banks to compare check endorsements with a master signature in a remote file suggests other library uses. Yet another management use, again borrowed from industry, would be the monitoring of library building exits to reduce depredation and vandalism.

To sum up the administrative uses of modern communication systems in libraries, it would be fair to say that, in recent years, they have proliferated where size and complexity have made conditions favorable. They have been borrowed extensively from business and industry, and reflect recent rapid development of electronic techniques. Generally speaking, however, the nature of the applications has been conservative; libraries themselves have not pioneered in developing new techniques for internal communication.

By contrast, American libraries have been bolder in finding new types of uses for interlibrary communication. The philosophic and economic bases for increased library interdependence, and hence communication are well-known, and the trend has been well reviewed by McAnally,[5] Carlson,[6] Fussler,[7] and others.[8] Competition for library resources has become uneconomic, and specialization, as demonstrated by the Farmington Plan, has become a necessity of research library development. Specialization implies cooperation and intercommunication; therefore, it behooves libraries to experiment with communication devices which promise to facilitate the sharing of each other's resources.

Interlibrary communication may therefore be considered as a necessary complement to the scattering of resources. Further, it may be considered as a control on uneconomic competition in library development.[9] Such communication makes possible the establishment of "satellite" systems wherein a metropolitan or regional library may service the extraordinary demands of peripheral service libraries.

Interlibrary communication has taken two forms: the first is concerned with the transmittal of information about the library's resources, and the second with transmittal of facsimiles of the resources themselves. The former is an adjunct to the library's reference services, the latter to its loan service. This distinction, based in part on the characteristics of the instrumentation available, has not always been made in library planning.

Foremost among interlibrary communication systems applied to the transmission of information derived from the library's resources is, of course, the Teletypewriter Exchange System, or TWX. Essentially this is a national (and international) closed telegraphic system offering service on a rental basis. Messages are typed on a teletypewriter, which converts them to electric impulses which, at the receiving end, are reconverted to type automatically. Jolly has reviewed the development and use of TWX in the United States up to 1954.[10] The first library installation, made in January 1950, connected the public libraries of Milwaukee and Racine.[11] It developed from the need of the "satellite" libraries to borrow materials frequently from the larger metropolitan system. Racine is an industrial community; thus it is significant that in a three-months spot check, 45 per cent of the 248 books borrowed from Milwaukee were scientific or technical. Racine's primary purpose was to reduce the time for making interlibrary loans, later to be picked up by a messenger, by wiring requests in advance. A secondary purpose was to receive quick answers to reference questions.

Original estimates for the RACMIL system established a cost of 77 cents per item borrowed, including the prorated cost of equipment rental, messenger's time, and a Milwaukee Public Library service charge of 22 cents a volume. The estimated cost of answering a reference question was set at 60 cents. When the TWX rental cost doubled in July 1953, these cost figures were redetermined at $1.02 per item for borrowing, and 75 cents per reference question answered.[12] Recent experience has shown a decline in items requested by RACMIL, attributed in part to the development of information resources in the industrial firms serviced, but the RACMIL circuit is still continuing.

The "Michigan Circuit" was established by the University of Michigan, the Detroit Public Library, the Grand Rapids Public Library, and the Michigan State Library, to help meet cooperatively the emergency caused by the Michigan State Library fire in March 1951. During its brief career, it was very successful in permitting state-wide library cooperation, but it became a victim of the sharply increased rental charges inaugurated in 1953.[10]

The most ambitious TWX installation has been that developed as a service adjunct to the Midwest Inter-Library Center, Chicago. The system was established to provide quick access to materials deposited by the sixteen research library members to the materials placed in storage at the Center. Fourteen of the sixteen libraries installed TWX

equipment, and the major cost of the service until 1956 was borne by the cooperatively budgeted MILC. The total annual cost to the Center has been estimated at $2,767. The traffic has not been as heavy as was originally anticipated, there being but 464 requests received between October 1954 and September 1955. The cost per unit for this period, averaging both incoming and outgoing messages, came to $2.36.[13] The increased cost and the decreased traffic have been a matter of concern to MILC's directors, a number of whom believe firmly that the actual and potential value of the system warrant its retention.

As an adjunct to its "common pool policy" which considers the eight separate library systems of the University of California as a large reservoir from which the faculty and graduate students of any campus can draw, the University of California has established a TWX system designed to facilitate their intercommunication. It is used primarily to reduce the time taken by interlibrary loans and to answer reference questions from specialized resources. A potential use is its substitution for a proposed union catalog.[14]

Other single installations of TWX include one between the Linda Hall Library and the University of Kansas Library,[15] and one at the Denver Bibliographical Center. A recent variant is the Library of Congress' use of its TWX in speeding orders to booksellers.[16]

There is no doubt but that the 1953 price increase on TWX messages slowed down a highly significant interlibrary communication development. Whether this dealt a death blow to the possibilities of rapid telegraphic information about books is essentially a problem involving the economic value of the information sent and received. The Midwest Inter-Library Center is handicapped in one sense in that the materials deposited with it were considered of marginal value originally. Present-day society assigns higher cash values to information in the sciences and technologies, and presumably further development of TWX will be along lines where the system "pays off."

As contrasted with a system which expedites conventional library reference services, facsimile reproduction offers a substitute for the loan of library materials themselves. Interlibrary loans are expensive, they are slow, they preclude the local use of materials during the course of the loan, and they are risky. The use of microfilm in lieu of loan owes its strength to the fact that it obviates some of these difficulties. Microfilm is a facsimile recorded by a photographic process and transmitted by mail. It is cheap, it permits retention of the material "loaned," but its transmission by mail is still slow and cum-

bersome. From its earliest application to library service, microfilm has offered an attractive substitute for interlibrary loan.[17]

More recently, the communications industry has developed new techniques for the instantaneous facsimile transmission of information. The objective of those interested in advancing interlibrary facsimile communication is to find, develop, and apply one of these techniques as a cheap and rapid substitute for interlibrary loan.[18] Efforts so far have been concentrated in the scientific-technical library area, since the unit of information required, the scientific-technical paper averaging ten pages, lends itself economically to electronic transmission.

Facsimile transmission, as a "black box" concept, is relatively simple. The copy to be scanned is moved under a zig-zagging pencil point of light. A reflection of this light spot is sensed by a photo-cell; wherever black occurs—for example the ascender line of the letter "b"—the photo-cell generates a "blip," or a modulation on a basic carrier wave. These "blips" are transmitted by telephone or high frequency radio to a recording device, where they are reconverted to graphic images. The technique has long been in use for the transmission of radiophotographs.

The standard equipment used for radiophotographs and the devices now being developed and sold for industrial use have the disadvantage of being "drum scanners," designed to accommodate a single sheet of paper locked, like a mimeograph stencil, around a slowly revolving drum. On the other hand some new RCA equipment, developed according to the specifications of the Atomic Energy Commission for a library situation at Oak Ridge,[19] is a "flat bed" scanner which incorporates a book holder similar to a microfilm camera cradle. Its other distinguishing feature is its relatively high speed; where photos are commonly sent at a rate of four inches a minute, the RCA model moves copy at a maximum rate of fifteen.

At Oak Ridge, where the equipment was first installed, several factors mitigated against its success.[20, 21] It was later moved to Washington, loaned to the Library of Congress, and tried first as a communication link between that library and the National Institutes of Health, and later between the Armed Forces Medical Library and the National Institutes of Health. Largely for mechanical reasons, the Washington experiments with the prototype equipment have been less than successful. During a period of maximum productivity (July-November 1954) 140 transmissions of periodical articles averaging ten pages in length were made at an estimated unit cost of $3.92 or 39

cents per page. At 200 transmissions per month the unit cost could have been reduced to $1.53.

The general conclusions reached as a result of the Washington experience were:

1. Facsimile as a substitute for interlibrary loan is acceptable to the user. While there is room for improvement, legibility is satisfactory. Particularly appreciated were the retention factor and the relative speed of service.
2. Facsimile can compete with loan and photoduplication only if sufficient volume is attained.
3. The industrial development of facsimile for interlibrary communication should be continued.

Warheit [21] has pointed out the pitfalls in predicating service on experimental equipment, and Shaw [22] has suggested the limitations imposed by its maximum theoretical daily capacity (480 pages). In forecasting the future development of interlibrary facsimile communication, therefore, it is necessary to proceed temperately. The point should be made that experimental equipment demonstrates potentiality, rather than actuality. Pioneer television was costly, subject to breakdown, and inefficient.

The limitations involved in facsimile communication are the limitations demonstrated by one experimental model, the RCA remote high-speed facsimile duplicator. Scanning speed, as suggested by the Ultrafax demonstration [23] is more than satisfactory, it is recording speed which is the bottleneck. A high speed recording, preferably non-photographic, of an entire page on the face of an iconoscope tube, would reproduce an entire page in a matter of seconds.

Librarians both in this country and overseas have maintained a close interest in facsimile development.[24] In general, they are divided between those who see in interlibrary facsimile communication a major development which will profoundly affect the course of research libraries,[9, 18, 25] and those who remain skeptical of the potentialities of the equipment.[21, 22] Perhaps too much has been written on the basis of too little experience, and more tests are needed with a variety of devices before the question can be resolved. At any rate industrial facsimile communication is developing at a rapid rate.[26] The problem of further development is essentially that of creating a library market for the industry.

As for the future it would be well to review the conditions which must underlie further development in interlibrary communication:

First there must be economic advantage. A facsimile system should offer the promise of savings. It must do the same thing accomplished by interlibrary loan better and at less cost. It would thus have the potential of curtailing duplicative expenditure for library collections so that competitive acquisition may be sharply reduced. Actually, a system is most likely to develop where the information it supplies must be found quickly. Speed of communication is of more value in the sciences and technologies and in commercial enterprises than in the humanities.

Second, as a prerequisite to the development of a communications system, there must be a homogeneity of interest among the individual units to be joined together by the system. The library complex of a given metropolitan area, or of a given geographic region, suggests a functional basis for systems development. This is the repository-satellite relationship, which may take dozens of forms, but which is a fundamental condition to the establishment of a system.

Third, the system must be designed to transmit only such parcels of information as are economically defensible. An encyclopedia article is one thing; *Gone With the Wind* is another. Short units, such as scientific papers, law reports, specifically cited pages in periodicals or books, at present, constitute the economic unit.

Fourth, if libraries wish to adapt facsimile communication to their functions, they have the responsibility of making their needs known, and of promoting the commercial development of equipment meeting library requirements. A rapidly developing field will of course seek a profitable market,[26] and, so far, industrial applications have offered the greatest stimulus to design and experimentation. Libraries interested in improving their intercommunication have the responsibility of making their needs known.

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Transportation Equipment

CARL VITZ

THE MEASURE OF ACCOMPLISHMENT of the machine age is the efficiency of the logistics by which product meets consumer. Efficiency, in this sense, is evaluated in terms of moving man and material with the least effort, at the least cost, in the least time. Too seldom has the library been designed with proper consideration to its potential measured by this standard. Yet to user and staff alike, the measure of success or failure, of pleasure or pain, of every existing library is exactly its original logistic efficiency combined with its flexibility to meet the further demands of growth, change, and expansion.

The library, as a monument, hardly recognized this approach, nor could it be expected to. Before electricity the very seeking of natural light and ventilation seemed more important goals. Heavy walls combined the functions of structure and enclosure. Accelerated rate of acquisitions, demands of new media, increased costs of staffing all have hastened the obsolescence of existing structures. The pretty monument, enveloping the complete library conception in its inflexible shell of one or another appropriate style of architectural treatment, with its arbitrary subdivision of space, denies internal growth in crowded inefficiency, confounds rearrangement and defies enlargement. Imaginative librarianship may mask the effort to the uninitiated, but wasted space, awkward arrangements, extra steps, the useless expenditure of human energy, daily strangle the desired service. The problem is not so much the lack of storage facilities, though these are seldom adequate, it is the frustration of access and internal transportation that causes the log-jam.

Logistics, then, is the problem. To design a practical library it is necessary to consider the things to be transported, and keep in mind that the future will only extend this list. Here are some of the basic requirements:

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In any sound solution easy access of reader to book is a prime consideration. The catalog and staff should be placed to be of the greatest assistance, the user's route should be well marked and require the minimum of time and effort to traverse. The patron should find readily quiet pleasant surroundings for browsing, reading, or study as he desires. His activities should be supervised without hindrance and his means of departure should be direct and with the minimum sense of control.

The staff should be accessible to serve him when help is desired, and should be able to do so promptly, pleasantly and with the minimum of unnecessary effort. Each staff member should be strategically located in comfortable surroundings to be most effective in applying his best skills and should be relieved of wasted time-consuming effort in the accomplishment of his task. All material should move directly and quickly to its destination and with the minimum of error, confusion, and effort. The structure should be comfortable, clean, orderly, quiet, cheerful, and pleasant for all occupants. It should be economical to maintain and operate, and flexible to adapt to changing demands.

The key to the proper functioning of the above is the plan relationship of all the various activity areas, one to another, and the provision of means for the movement of many things, each to its proper destination, without interference, confusion or undue effort. Circulation, in the architectural sense of the word, is the complex of paths by which things move.

The types of things to be moved in libraries cover a wide range of sizes and shapes as follows: people (public and library staff); library materials (books and other printed materials, large and small, bound and unbound; periodicals; newspapers; maps; documents; manuscripts; films; microfilms and microprints; recordings); messages (written and verbal); equipment; furnishings; supplies; waste and scrap materials; fuel; air (warm and cold); water (hot and cold); heat; light and power (in the form of electricity).

The moving of fuel, heat, water, air, and electricity fall in the realm of plumbing, heating, ventilating, air conditioning, and electrical installations, and although the efficient distribution of these elements is of increasing importance, this paper will deal primarily with the circulation of people, messages, and media for the diffusion of knowledge.

The basic circulation problem in libraries has not changed since man began to collect and catalog information. It has always been, simply, to bring the user to the information or the information to the

user. Obviously, the first means of transporting information in the form of scrolls, tablets, and later books, was by leg and arm power. People carried things and moved vertically by means of stairs, ramps, and even ladders. No significant change in this system occurred from the beginning of time until the introduction of mechanical devices in relatively recent times. Consequently the physical design of libraries was determined by the necessity of keeping the books close to the readers. In the early libraries, as for example in the monastery, the collections were small enough to be shelved in one or two rooms in which the readers also worked. As both readers and collections grew in number the problems of storage and access multiplied. The stack in its more recent growth developed many forms and arrangements, assisted by, and resultant from, increased use of developing mechanical equipment. The central core stack, the higher core or tower stack, the stack on a side, in an adjacent wing, etc. and now the underfloor stack, have all developed in the search for a better arrangement.

There is no one right answer. Depending on the type and size of library, the validity of arrangement is dependent upon the simplicity of arrangement of circulation patterns, the flexibility for change and growth and the selection of applicable means of transport. The goal is always improved service, reduced cost of operation and increased usefulness of staff. The trend is from the purely physical activity of the page boy carrying a book, or a patron walking up stairs, to the automatic operation of the elevator, electric lift, or moving stairway.

It seems remote that library operations will become completely mechanized, but with the technical knowledge at hand it would be possible to devise a system by which the patron activating a push button on an "electronic catalog" could have any book delivered to him by conveyor and charged out without a library attendant having touched it. The cost would be prohibitive and the practicability of such a system doubtful, but the coming years are sure to bring remarkable advances in transportation equipment. It is also conceivable that the very form of books may change. The sudden surge in the use of audio-visual materials, microfilm and microprint in the last few years has already forced new techniques in library administration and changes in library space allocation. The library described as a "department store of knowledge" focuses attention on the importance of moving people and "merchandise" with smoothness and speed.

Mechanical equipment and transportation can be evaluated only in terms of its ability to justify its cost and the purpose it serves. Automation in manufacture is only possible because of the reduction in

labor cost spread over repetitive operations in producing in quantity a profitable end product. In library use no such profits exist. Expensive mechanical devices must meet the tests of: 1) reduced cost on the basis of long term operation, 2) improved service within reasonable limitations of justified expenditure, or 3) reduced space resulting in lower initial capital outlay.

As the demand of library use seldom is profitable enough to enlist inventive genius or to encourage venture capital to manufacture complicated equipment for its use alone, most forms of transport involve adoption of means already developed for more general application. The librarian and architect jointly must clearly evaluate each available device and the arrangement of space required to make it effective.

A check list of transportation equipment for libraries includes the following: stairs (public, staff, emergency exit); ramps; elevators (public, staff, freight); escalators; lifts or dumb-waiters; book and message conveyors (vertical, horizontal, combination); book trucks; handling and maintenance equipment. A discussion of each item will point out considerations in selection and arrangement.

The monumental stairs, opening a large well between floors, is rapidly disappearing. It is wasteful of space and makes fire-control between floors difficult. Today's patrons do not find stairs inviting but look, rather, for easier means of transport.

Fire exit stairs, required by law and safety, should be well-marked yet controlled against improper access to non-public areas of the building. All stairs should be placed to prevent patrons from leaving the building without passing check-out desks or other controls.

There should be, if possible, no changes of level requiring ramps in new structures. Their major justification in the past has been to make handling of book-trucks possible where stairs only were provided. Where slight changes of level are imperative the grade should be held below the normal legal minimum and non-slip surfaces used.

Placement of elevators is of prime importance. Public elevators should be as centrally located as possible to shorten lines of public travel to all departments. They must land at the entrance level at a location such that the charging desk, or control desk, lies between them and the exit.

Staff elevators should be centrally located, large enough for book trucks, and preferably should not be accessible to the public. Lines of travel by staff to this elevator should conflict as little as possible with public circulation.

The freight elevator should be placed so as to cause a minimum of disturbance, yet be readily accessible. It must connect all floors with the service and maintenance areas of the building. It should open into a closed vestibule at each level where objects may be accumulated awaiting movement. It should be large enough to handle all furniture and fixtures on upper levels. Its location, so often determined by the service entrance to the building, must be carefully studied at each floor in its relation to the areas it must serve with the minimum of disturbance during hours of library operation.

Where possible all elevators should have stops at all levels. This allows all elevators to be used in speeding the initial move, and gives flexibility for changing use of all levels. Where elevator use is contemplated, the provision of a pair insures uninterrupted use during servicing, maintenance, and breakdown.

Automatic push-button elevators are rapidly replacing operators. The increased initial cost has justified itself in the reduction of long-term wages. A helpful person acting as starter can do a great deal to instruct the uninitiated in the operation of the elevator and to encourage and assist the timid. In the sandwich type structure of public floors separated by stack levels, public elevators may by means of key control of stack floor push buttons, restrict unauthorized access to non-public areas.

The selection of elevator speed requires careful consideration of the number of floors, number of people, size and load capacity of the car. Elevators too slow, are annoying and wasteful of time; high speed elevators are costly and ineffective in low structures. A good compromise can usually be found between speed and cost. There should be at each elevator door up and down call buttons and an indicator showing direction of travel of car. Each car should have easily read push-buttons and a floor indicator. Passenger and staff elevators should be self-leveling and have all doors automatic.

Although at first glance escalators may appear unnecessary for library use there are occasions where they may be amply justified. For large libraries with many patrons an escalator makes a second floor psychologically as accessible as the entry level, with no pause required for vertical transportation. The main objections are high initial cost and the added space requirement. Where by installation of escalators the required elevators can be reduced in number, the net cost is correspondingly reduced. Department stores have found escalators necessary in the hard world of competition. Banks and office buildings are coming to use them more and more. Libraries

may find them an added inducement to a fuller use of their buildings.

The book lift is a miniature elevator, and has many of the same advantages and disadvantages. It can connect adjacent levels vertically and can continue through the building to connect all levels for interdepartmental use. The placing of book lifts in building plans must be carefully thought out. With the trend in organization toward subject departmentalization it is necessary for each subject department control desk to have immediate access to a book lift connecting it with its stack area. On the stack level, the optimum location for the lift is the center of the subject department book collection, and the location of control desks, lifts, stack stairs, work areas, etc. must be balanced to achieve the best possible circulation pattern. It is possible to make a single book lift serve more than one department.

In the accomplishment of automatic operation the book lift has certain obstacles to overcome. It is not as yet an automatically unloading device, which means that a delivery to a point must be unloaded manually before the cage is called to another stop. This interruption is not serious when the lift is used between one department and its stack, but as an interdepartmental connection this can cause confusion and delay. The lift should be set up to signal the control desk with a light and/or buzzer that the cab has arrived. The lift has the further planning disadvantage of operating only vertically. Perhaps the future will bring a device which will combine the best features of the various book conveying mechanisms. The main advantage of the book lift is its ability to carry a variety of sizes, shapes, and weights, from a single sheet or pamphlet to a bulky bound newspaper. No other vertical system has this flexibility.

Conveying equipment may be used in many places to advantage in the modern library. Continuous automatically unloading book conveyors can connect all levels vertically; belt type conveyors can serve to transport books horizontally or diagonally up or down from the return desk, night return, or automobile book return station. Roller or belt conveyor systems may speed the sorting and distribution of incoming books and supplies and, in a central library, of material and books for distribution to branches. Gravity conveying systems utilizing chutes, drops or rollers probably have limited usage. Unless placed in protective containers, books may be easily damaged in a chute or slide, and for messages a gravity drop must operate almost vertically.

The continuous vertical book conveyor is a device which usually connects all working levels. A chain moves continuously over wheels

or sheaves at the top and bottom of the shaft, and carries forked baskets on which the book is placed. The operator selects by push button the level at which the book is to be discharged, the book dropping off the conveyor into a canvas sling or a box with a depressible bottom. A book may be sent from any station to any other, but as it unloads only as it descends, a book traveling from a lower level to a higher one must rise the entire height of the building, and come back down before being discharged, resulting in some delay in the delivery. The standard vertical book conveyor will not carry books larger than quarto size and is expensive to install.

Pneumatic tube systems using small cylindrical cartridges provide a convenient, rapid, and sure method of transporting call slips and other written messages from the control desk to the stack areas and reverse. The TelAutograph is sometimes substituted for this purpose. While the pneumatic tube carries the borrower's call slip to the stack and it returns with the book, the TelAutograph requires staff copying. The pneumatic tube, thus, tends to reduce time and error. A telephone or other device for verbal communication increases staff time and chance of error to the point of being impractical for anything but the most occasional use.

Large flat pouches capable of carrying octavo-size books with considerable speed can be used in a pneumatic system where the volumes are predominantly of this size, but the pouches are heavy and women are reluctant to use them. The pneumatic systems have the advantage of being able to turn corners, and are more flexible in plan than belt or chain types of conveyors. Their use for books, however, is not generally advantageous.

Good planning of building circulation, in short, should reflect direct conveyor runs, resulting in lower initial and maintenance costs.

The all-purpose book truck, standard in size and design, needs careful examination. It is in fact a movable shelf and an expensive one at that. It should be small for easy movement and access to limited areas, high enough for easy consultation by persons when standing, and the shelves should tilt for better visibility. But why can it not take different forms for different uses? In order and cataloging it may well take the form of a movable shelf on wheels and may move the great majority of books through several stages without repeated removal to desks or fixed shelves. On the other hand book return carts with depressible bottoms would be better for collection and sorting. Likewise stacking bins and pallets would simplify sorting and shipment to branches.

The supermarket cart has been found economical and useful in libraries, the light, manual hydraulic fork lift, the dollie or the hand truck so effectively used in handling soft drinks, should suggest appropriate uses. The test is the extent of reduction of time and effort against the cost. The alert librarian and planner might well observe material handling methods and equipment used in business and industry, and find applicable uses within the library.

The normal processes of collecting waste, cleaning, polishing, mopping, and waxing all require equipment. Mop trucks greatly simplify cleaning by speeding the process and reducing the effort of the janitor. Light elevating roller scaffolding reduces cost of maintenance of lamps and cleaning of high ceilings and windows. Exterior roof-hung window washing devices reduce the danger and the cost of window washing and exterior maintenance. Carts for carpentry, electrical, plumbing, and heating maintenance increase efficiency and reduce the proverbial return trips.

Special Considerations. Clear, well placed signs, indicating his destination to the uninitiated, help reduce confusion and save staff time. Material and color selection used consistently throughout the public floors may indicate instantly the location of elevators, stairs, exits, the location of staff assistance, and many other areas or services, or, at least, simplify the giving of directions when requested. Placement of desks, displays, and bookcases can serve to guide traffic flow. Distinct identification of shelves, stacks, and catalogs guide the reader to his desired subject matter. Planned arrangement of repeatedly used material so that it may be readily found and used simplifies the search and encourages reader participation.

Many methods are used to encourage the return of books to the library. Certainly the normal book return function should be located adjacent to the entrance for the convenience of the borrower. An automobile return window will be very handy in congested areas, or where this is not possible, sidewalk devices have proved practical. Night book returns, open when the library is closed, are widely used. The design and arrangement of these devices to reduce damage to books and simplify collection for sorting requires thought and ingenuity.

Meeting rooms where large numbers of people will gather for lectures and other activities should be located at ground level if possible, to simplify the problem of required exits, ease strain on the vertical transportation, and reduce the noise problem. As ground space is usually at a premium, location elsewhere requires careful consideration.

Staff facilities such as lockers, toilets, vendors of coffee, soft drinks, etc., should be widely distributed for easy staff access to reduce travel time and staff elevator load.

Public toilets, if too near the entrance, often tend to become public comfort stations in effect, and encourage unwelcome traffic of non-library users. Public toilets should be located so as not to disturb nearby departments.

All shipping and receiving functions of the library should focus at one location, conveniently accessible to trucks of all sizes, sheltered from the elements and laid out for proper supervision and control. The more unpacking and sorting operations are located here the less inconvenience will result to the rest of the building. The entire area should be at truck level height and should be near the freight elevator. Where the platform height would require ramps or changes of levels elsewhere, thought should be given to hydraulic platforms to facilitate trucking operations.

True flexibility involves the very practicality of the entire building to adapt itself to changing demands, new media, and growth. Flexibility frees the building and its functions to meet future needs and stave off obsolescence. The minimum of fixed walls, simplification of all circulation patterns, ease of access to ample crawl space between floors for mechanical and electrical maintenance, changes and additions, even the construction of the exterior walls as curtain walls, independent of building support, so that they may be removed or altered, all are considerations that must not be overlooked. Careful thought for expansibility far in excess of normal planning, and a clear indication for the direction for such expansion, should not be forgotten. These factors may have little apparent relation to transportation at the outset, but as time creates its inevitable pattern of growth and change they are considerations which allow the building of today to enlarge, change and adapt itself to future patterns unknown.

The architect and librarian must design to the highest standard of known usefulness and project into the design the means for future improvement and extensibility. Buildings should not run down, they should run forward. It is to be hoped that not another library will be built which to a later generation will be as cramped, obsolete, hemmed in, and intolerable as those now being replaced. Newness is not necessarily goodness, nor vision. Imagination is limited by the forseeable future, however far extended, but vision is the projection beyond that, providing opportunities for future hands to seize. Judge a building not by its age, but by the vision it contains to make it ageless.

Office Machines and Appliances

JEWEL C. HARDKOPF

HOW MANY LIBRARIES are using office appliances and are they using them to perform the conventional office operations for which they were designed, or are they adapting them to perform library routines?

In 1940 the *A.L.A. Bulletin* carried an article entitled, "Equipment and Mechanical Devices Adapted to Use in Libraries,"[1] in which the author listed types of equipment which were efficient but not widely used in libraries. The items included floor coverings, exhibit cases and lighting devices, as well as duplicating machines, card sorting systems, and smaller gadgets like book-clamps, and pasting machines. The article included a list of institutions using each item. If such a list were prepared today, would it be very much longer?

In 1941 a questionnaire was sent to nineteen of the larger libraries in California for the purpose of surveying the existing practice in the use of modern mechanized equipment.[2] Would a similar questionnaire sent out today bring to light much wider use of office appliances?

From an examination of the volumes of *Library Literature* from 1940 through March 1956 under the headings: Mechanical aids, and Machines and the library, it appears that very few librarians are inclined to write about the mechanization of library routines, if indeed they have adapted office appliances to library needs. From 1940 through 1945 only fourteen articles were listed; from 1946 through 1954 there were eighty-four articles. Among these eighty-four it was noted that more than one third dealt with either punched cards or electronic machines.

There is a tremendous amount of literature available detailing the obvious advantages of using office appliances in office routines, and describing the saving of labor and time and the increase in output. In the March 1956 issue of *The Management Review* the following statement appeared:[3] "Estimates of the current shortage [of office workers] range from 600,000 to 1,000,000. In large cities the search

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for white-collar personnel is all but frenzied. Smaller urban centers are caught in the squeeze too."

Most librarians are well aware of this shortage of clerical assistants, and many have been examining clerical routines with a critical eye to determine where labor savings could be effected.

One of the largest items of expense in library operations today is the cost of personnel. But the prevailing scarcity of library workers frequently presents a more serious problem to the library administrator than the finding of adequate funds for the salaries and wages budget. It is to be expected, therefore, that the trend towards mechanization of library operations with modern, efficient office appliances will proceed with an increased impetus in the years immediately ahead. And it may be presumed that the selection and use of appropriate machines will receive the most careful consideration of library administrators so that library operations may be accomplished efficiently at minimum labor costs.

More and more articles are being written by librarians who have put machines to use to save time, to promote accuracy, or to eliminate work that is monotonous in character. In the sharing of such experience, reference is usually made not to such "old standbys" as typewriters, adding machines, calculators, voice recorders, and similar types of equipment used in the performance of ordinary office routines, but rather to variations of use, adaptations peculiar to libraries, for example, the use of dictating machines in audio charging of books to borrowers. Today's alert and progressive library administrators are eager to know all the details of imaginative and ingenious applications of office machines made by their colleagues. There is a growing realization that considerable versatility and tremendous developments in this area lie in the very near future for all libraries.

The need for the mechanization of a library routine should never be taken for granted. Nor should one accept the present method, the job as it is performed, without question. No librarian should ever decide to buy an office appliance because another librarian extols its value to his institution. Each must ask himself: Is the machine really needed in my library?

Perhaps the work itself could be eliminated, simplified, re-scheduled, or altered in such a way as to eliminate the necessity for mechanization. If it is determined that the operation is essential, some thought should be given to the possibility that the work is only temporary rather than permanent. If it is permanent, it may be possible to do the work by some simple non-mechanical means. An excellent example

is the practical device known as the slide rule, which is rapid, inexpensive, and sufficiently accurate for many purposes. It is not wise to be carried away by a machine's versatility or special features; they may have little or no application to the operations of the library, but will be included in the price of the machine.

The librarian who is contemplating the purchase of office appliances for their normal use in connection with regular office operations or for special applications to procedures peculiar to libraries will need to consider which of the following advantages of properly selected machinery are to be gained:

1. Reduction of costs
2. Reduction of monotony
3. Reduction of physical fatigue
4. Improvement of appearance of finished work
5. Improvement of quality of work
6. Securing of better control
7. Reduction of peaks and bottlenecks.

Mechanization of a library routine is often an invaluable aid in cutting costs but, particularly in the small library, it is important to remember that a machine requires a sufficient volume of work to effect lower unit costs. To be advantageous, time saved, if not applied to other essential library work, should result in a reduction of staff. If the time saved is simply dissipated and spread over other routines, there are no economic benefits.

If the primary goal of mechanization of a particular operation is to achieve a reduction in costs, the library administrator will necessarily have to make a comparative study of all costs involved in the operation as presently performed and those that will apply under the proposed mechanization. Having calculated the amount of probable savings, he would be well advised to check his results with libraries which have made similar conversions and who may have comparative cost figures based on actual experience.

Office machines, like other costly equipment acquired by libraries, must last for many years. That is why it is particularly important to make the decision to purchase only after the most careful consideration. Among other things, the final decision should be based on advice from librarians who have had experience with such equipment, consultation with manufacturers' agents, and a thorough inspection of competitive models. Apart from facts relating to the construction, operation and maintenance of the machine under consideration, the

competent sales representative may be counted on for information regarding special features and optional equipment. Any information he might have about imminent major improvements to be made in the current model may prove of particular importance. The possibility of rapid obsolescence of a machine soon after purchase is a serious matter, and any indication of such a possibility would suggest the wisdom of deferring the purchase for the time being.

The office appliance firm's representative is usually agreeable to arranging a trial period and willing to cooperate in a careful testing of the machine in the operation in which it is to be applied. Much of the uncertainty concerning the suitability of the appliance under consideration can be resolved in this vitally important part of any proposed purchase.

Whenever feasible, it is desirable to arrange a demonstration of the machine before interested members of the library staff. However, this should be done only after careful planning and preparation. In this connection, it is important to make sure that the demonstrator has not only a thorough knowledge of the machine and its operation, but has acquainted himself also with the problems peculiar to the particular operation in which it is to be used.

The choice of an office appliance, the particular make or model, will be influenced by a number of factors. Any one of the ten factors suggested in the questions listed below may be of dominant importance and, therefore, might justify the selection of a particular type, make or model of office machine.

1. Does it have the specific features to meet the requirements of the operation to be mechanized?
2. Does it have desirable flexibility or adaptability to meet special needs of other operations?
3. Will it improve service to library users?
4. Will it increase the output of the operation?
5. Will it improve the quality of work performed?
6. Will it reduce the drudgery involved in the operation?
7. Will it reduce costs of operation sufficiently to offset the expenditure within a reasonable period?
8. Does it involve special problems in the training of operating personnel?
9. Is it free from special problems of supervision, operation and maintenance?
10. Is it assured of acceptance by staff members?

Since most office appliances represent expensive, long-term investments, final decisions concerning purchases usually rest with the chief librarian, who may be expected always to keep in mind the best interests of both the library staff and the public it serves. His individual preference will ordinarily not enter prominently into the selection of office appliances. But he will make sure that in the planning for the mechanization of a library operation the welfare and morale of the staff have received full consideration.

From the point of view of efficiency and cost-savings, there are no disadvantages involved in the mechanization of library routines, if the machines are carefully selected. In this area, library administrators' original sin derives from an indiscriminate enthusiasm for mechanization.

Office machines can be properly maintained only by considering all service factors together and planning their control. The factors involved are: (1) control of machine adjustments, (2) control of wear and mechanical condition, (3) control of lubrication, and (4) control of machine clean-up. Generally, the manufacturer has inspected and tested the machine before making delivery. When it arrives at the library, little concern needs to be felt as to its mechanical condition, but attention should be given to proper adjustment, lubrication, and clean-up procedures. This is the time to set the pattern and to establish standards for the control of the machine which will assure efficient operation in regular production. Each operator should receive full instructions regarding the proper operation and maintenance of the machine and a supervisor should see to it that the manufacturer's instructions are carefully followed.

In the matter of providing satisfactory machine maintenance, a library usually has a choice of several plans or combinations of these. Many manufacturers or service agencies offer a service contract, at a specified annual charge, providing for periodic servicing of the machine and stating conditions and rates applying to special service calls. A library may decide, of course, to call in a service man only as the need arises, but, in the long run, the cost of this plan may exceed that of a regular service contract. If the library is so fortunate as to have on its staff help with the necessary mechanical know-how, it can provide its own maintenance service and, in this way, keep maintenance costs at a minimum and also avoid the loss of time, in case of a minor breakdown, incurred while waiting for an outside service call to be made. The choice of plan naturally will be determined on the basis of which one will come closest to

providing uninterrupted service at the lowest maintenance cost.

There are many answers to questions concerning depreciation, what estimated rate of depreciation should be used, and when it is economically sound to purchase a replacement. The most commonly used rate of depreciation is ten per cent, or a period of ten years. In this connection, Bulletin F of the Internal Revenue Bureau, which gives the estimated average useful life of office equipment and machines, will prove useful.[4] According to it, the life expectancy of selected items is as follows:

Files	15 years
Office machines:	
Adding	10 years
Billing	8 years
Bookkeeping	8 years
Dictation	6 years
Typewriter	5 years

Usually the cost of the machine is written off in a constant yearly amount. However, in some instances thirty per cent or more is charged off at the end of the first year and smaller percentages each succeeding year until the full amount is absorbed.

The library administrator should determine replacement schedules so that machines will not be kept beyond their useful life. In this connection, the question of trade-ins needs careful study. Some over-all policy, allowing for exceptions in special circumstances, should be adopted in each library, based upon individual circumstances. The decision regarding a trade-in is influenced by three factors:

1. Availability of funds
2. Expected cash savings resulting from the installation of a new machine. Will these savings pay for the net expenditure within two years?
3. Difference between the accrued net depreciation and operating expenses; that is, the net (present value minus trade-in) should be less than the cost of repairs.

A complete annual inventory of all office machines should be carried out. For this purpose an inventory card file, which includes a separate card for each item of office machinery owned by the library, is recommended. The entries in the file should be under item, e.g., typewriter, followed by the name of the manufacturer. In addition, the card should state the operation for which the machine is used, date of

manufacture, model and number, location in the library, date of purchase and price, maintenance record and expenses, and the inventory number corresponding to the one put on the machine at the time of purchase.

The balance of this article will be devoted primarily to descriptions of office machines which are considered useful in the performance of library routines. The purpose of this presentation is intended to broaden the reader's knowledge of modern office machines, but a detailed account of the different types, styles, sizes and models of the machines which are on the market today will not be attempted. Rather, it will offer a summary outline of some of the important kinds of machines and their functions.

Accounting machines are most useful in eliminating manual operations relating to the following records and procedures: (a) accounts payable; (b) accounts receivable; (c) payrolls; (d) analyses of costs and purchases; (e) preparation of general ledger and general journal; (f) preparation of rapid, accurate accounting facts; (g) posting of checks and deposits to ledgers and statements; (h) specialized applications for municipal offices (i.e. public libraries reporting to city government).

A complete bookkeeping machine produces multiple records with mechanical proof for every entry, instantly computed account balances, and automatically accumulated account control figures.

In selecting an accounting machine it will be necessary to consider four types:

1. Single-print, which allows ledger card and invoice to be prepared simultaneously by using carbon paper.
2. Multiple-print, in which the ledger card and statement are placed side by side in the carriage, the machine posting to the one, and then moving over and printing the same information on the other.
3. Flat bed, characterized by a flat printing surface which permits invoices and ledger cards to be inserted.
4. Window plan, designed for windows or counters by employee operating machine in a standing position.

The question as to whether a bookkeeping machine should be purchased should be answered by comparing the cost of manual posting, billing, and preparation of payroll records, with the cost of performing these functions mechanically (usually at a rate of 80 to 100 accounts per hour). Some authorities say accounting machines should be purchased when the number of daily transactions exceeds

200. However, the use of small bookkeeping or posting machines for the preparation of statements and ledgers has reduced the time for these clerical operations in organizations with no more than 50 to 60 daily transactions.[5]

In the Brooklyn Public Library an accounting machine was purchased after it was determined by the bursar that the machine would save staff time. An increase in the volume of financial records had made the saving of staff time a necessity. By combining three operations into one (advice of payment, voucher, and check), and by mechanizing the preparation of the earnings records for all employees the accounting machine provided a solution to a very real problem. According to the chief librarian, "The cost of the machine has already been made up by the salary savings involved and we have reaped an additional benefit of better and clearer accounts since the recording is done in one operation."[6]

Calculating machines are little more than highly developed adding machines. There are two types; (1) key-driven, in which the mere depression of the keys causes the machine to operate; (2) rotary, in which, after the numbers on the keyboard are depressed, an activating key or crank must be operated before the machine will calculate.

Purchase of this machine is justified whenever any of the following tasks occur regularly and with some frequency: (a) preparing payrolls, for multiplying hours worked by the rate; (b) preparing stock room inventory figures, for multiplying unit cost by quantity; (c) computing percentages, as required in figuring per cent of increase or decrease in circulation, registration, book stock, expenditures, etc.; (d) determining unit costs.

Multiplication and division computed mentally are slow processes and liable to error. Where the processes of computation like those mentioned above must be performed as a regular routine, the purchase of a calculating machine is justified.

Dictating machines can be used to record words in such a way that they may be retained permanently or temporarily for later use or transcription. The record may be in the form of a wax cylinder, plastic belt, plastic disc, plastic tape, or metal wire. Machines requiring plastic belts and discs seem to be in greater demand in recent years than machines using the wax cylinder. The latter has the disadvantage of requiring shaving after each use before it can be used again. When comparing dictation systems, the per hour cost of discs, belts, cylinders, etc., should be considered. Wax cylinders will take approximately eight minutes of dictation; plastic belts will take approximately 30

minutes; plastic discs on both sides, plastic tape, and metal wire units will take up to one hour of dictation.

A recent development in dictating machines is the recording machine to which up to 20 telephone-like microphones, situated in as many different locations, may be connected. Another method of dictating is the voice reporter dictation mask, with which the dictator speaks into a mask covering the mouth and nose. A comparative test made by the U.S. Navy gave the following results: [7]

Shorthand	75% accuracy
Stenotype	80% accuracy
Voice reporting	99% accuracy

The selection of typewriters, hitherto a relatively simple problem, may become somewhat more complex as a result of certain recent developments. In 1941, the Pacific Northwest Library Association's Committee on Library Supplies and Equipment reported a study initiated by a typewriter manufacturer which had for its ultimate aim the designing of a typewriter especially for libraries. It was discovered that by adding ten special keys a typewriter could be produced which would meet the needs of all departments of most libraries.[8]

A new standard typewriter featuring interchangeable type is likely to be of special interest to librarians. The innovation of interchangeable type is described as follows:

In making type changes, the typist never has to touch the type with her fingers, or remove work from the machine. Using a simple pair of tweezers, she removes the old type block, selects the new one, and snaps it into place. The secret of the method is a tiny spring retainer clip on each type block which snaps onto the type-bar; once in place, the character is as firmly fixed and perfectly aligned as ordinary type. . . . Foreign language characters, symbols, and punctuation marks will also be available to fill the typing needs of foreign legations, import-export concerns, and college foreign language departments.[9]

This same article quoted above reports that all current and late models produced by this manufacturer can be re-equipped with special type-bars to hold the new interchangeable type faces.

Electric typewriters are recommended for operations where more than five carbons are regularly required, or if master copies for use in duplicating, as in the multilith or Xerox process, are frequently required.

Automatic typewriters should be considered if the library has a need fairly often for quantities of individually typed letters which are

basically the same, but not identical, in content. This machine utilizes a roll of paper, similar to the player piano roll. When the letter to be typed has been coded into the roll, the roll is placed in the machine and the attached typewriter electrically types the letter with perfect accuracy. The roll can be coded to stop at points in the letter so that a typist may insert any variations from the form letter as needed. In libraries, in which similar, individually typed letters must regularly be sent out, as for example, in fund solicitation, in welcoming new members, and in announcing new gift books added to the collection, the automatic typewriter is most useful.

Attention should be directed here to a device which is often overlooked in selecting a standard typewriter—the ten key decimal tabulator, which enables the typist to indent to the exact position for typing columns of figures. Many users believe this feature will increase the speed of statistical typing for the average typist by fifteen per cent.[10] This increase in efficiency may well justify the additional cost of about $30 of the tabulator.

A label typewriter is now available which handles four sizes of labels simultaneously on a split platen. Only the particular label being typed will revolve on the platen. This machine can be used as an ordinary typewriter without any changes whatsoever. Libraries will find this useful for typing call numbers on strips of various sized gummed labels.

Typewriters with extra large characters are also on the market. These are useful in the making of shelf guides, labels, directional signs, etc.

The Vari-Typer is useful in libraries for duplicating book lists, book marks, brochures, and other pieces of publicity. A variety of type fonts is available and electrically controlled impressions assure each character receiving uniform impact regardless of the operator's touch. Before purchasing comparisons should be made with the standard typewriter featuring interchangeable type.

Teletypewriters combine the features of the typewriter and the telephone with the additional feature of providing a written record of the communication. The charge for teletypewriter service is approximately half that for long distance telephone calls. This machine should be considered when a library must communicate frequently with libraries in other cities, when an immediate answer is desired, and where a written record of the communication is of value. The application of the teletypewriter network to interlibrary loan communication is described elsewhere in this issue.

Addressing and embossing machines stamp or stencil information on large quantities of papers or cards in a fraction of the time which would be required if done by hand. They utilize a small metal plate or paper stencil on which the required information has been punched or typed. Metal plates are embossed with a graphotype or compotype machine. Paper stencils are prepared on a typewriter equipped with a specially adapted platen. Some libraries are using addressing and embossing machines for printing simple catalog cards,[11] book cards, adult registration, preparation of employee time cards and payroll sheets, and preparation of bibliographies.

The sign writing machine is most useful in eliminating the hand lettering of printed signs for the library. Important in the selection of a sign writing machine is the consideration of the variety of type, and the quantity of each one selected. There is a wide choice of sizes and styles of type available. The Brooklyn Public Library has found three inch characters satisfactory for the largest and quarter inch for the smallest, but keeps a generous assortment of sizes in between. The advantages of this equipment are described by F. R. St. John as follows:

> I think every library has the problem of handmade signs and posters. They are not only time-consuming for the average assistant but unless there is a person on the staff with special artistic ability most of the signs cry out that they are handmade. Our inexpensive equipment . . . produced during the fiscal year 1951-52 over 3,000 signs easily duplicating the same sign for each of our 50 units. It requires practically no experience to operate. We have found that the average intelligent part-time clerk can be taught to produce clean, good looking signs after a few hours of training.[12]

Papers placed in the rack of a folding machine are mechanically moved in such a way as to fold each sheet of paper in any of several different kinds of folds. There are eight basic folds most commonly used which most folding machines are equipped to handle: single, double, standard, "low" standard, accordian, "low" accordian, no. 6 fold for 6¾" envelopes, and baronial. These machines will fold at rates of 5,000 to 19,000 sheets per hour. They should be considered for purchase whenever a library has regular quantity distribution of publicity items such as book lists. If each week the library has occasion to fold sheets in quantities of a hundred or more, the purchase of a folding machine is probably justified.

Books, papers, bundles, boxes, or cartons placed in the rack of a

tying machine are tied mechanically about ten times faster than by hand tying. These machines are designed to adjust automatically to varying sizes of bundles or containers. Uniform, proper tension, the exact amount of twine and a secure, non-slip knot are assured. The convenience and efficiency of tying machines is appreciated particularly in binding divisions for tying into bundles periodical issues when assembling binding shipments and in branches departments for tying together bundles of library materials to be distributed to various branches and stations.

Any library administrator considering the purchase of new filing equipment which will increase production and reduce fatigue and waste motion would do well to investigate the rotating filing equipment.

Rotary files are designed for filing cards into sections of a rotating drum or wheel, combining features of compactness, accessibility and visibility. Both manually and electrically operated models are available. The desired cards are quickly located and placed within convenient reach by rotating the wheel. Rotary files are useful in work involving a single operator to work on files containing a large number of cards. A wheel with a 21 inch diameter has a capacity of approximately 5,000 3 x 5 inch cards, or approximately 4,000 4 x 6 inch cards.

In conclusion, it must again be emphasized that there can be no substitute for the analytical approach to the problem of mechanization of library routines. The librarian must arrive at a clear conception of his objectives with respect to mechanization. He must study carefully the present work situation and the routines involved in the operations which may lend themselves to effective mechanization. At this stage it is less important to be concerned about *how* the change will be accomplished than about *what* the change should be. In this the librarian can benefit by consultation with the staff members who perform the operation regularly, but in the end, it is his analysis and decision that will have to settle the question.

The mechanization of library operations is bound to proceed at an increasing pace, but as R. R. Shaw has so aptly put it, "The question is not whether we will mechanize but rather at what level of sophistication of mechanization we will find ourselves ten or twenty years from now." [13]

By itself, the machine will not bring the solution to the problem of easing the pressure of routine work on professional and clerical personnel. That can be accomplished only by fitting it most effectively into the operation to be mechanized, and in the adequate psycho-

logical preparation of the staff, proper training of personnel in the use of the new machine, and intelligent determination of the use to which the time and labor saved are to be put, play an important part. It is this that J. M. Connor had in mind when he wrote,[14]

> When machinery turns the library into a whirling, clicking, mechanical robot, it is time to stop calling it a library. . . .
>
> The installation of labor-saving devices should be encouraged, *if* the labor and time saved is converted into more services for more people, or better services. If an electric-or photocharger saves three to five man-hours a week, that's the time to start a part-time readers' advisory service. The use of an automatic addressograph or multigraph apparatus in the rapid reproduction of cards transforms two days per week of a typist's time into an afternoon assistant in the young adult room. . . .
>
> For every machine installed in a library there should be clear evidence of time liberated to set in motion new ideas and new services, or more of the established services, to the community.

Today, many librarians are alert to the potentialities of mechanization with respect to the improvement of library services. In the words of M. F. Tauber,[15] "Further improvements in the services which libraries can offer—on a large or small scale—await only the imaginative use of scientific management and the development of new machines and methods to implement new solutions to old problems." More of us should play an active and intelligent part in changing these potentialities into realities.

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Gadgets: Miscellanea, But Not All Trivia

RALPH BLASINGAME, JR.

JUST WHERE THE FIRST USE in libraries of mechanical trivia was made is, no doubt, thoroughly documented in the literature. Quite possibly, the first "gadget" to gain general acceptance was some device as simple but as effective as the rubber date stamp. Clipped to the end of a pencil, this little gem has saved thousands of man-hours, and assisted in relegating "library script" to the category of interesting leftovers in the card catalogs of university libraries. Somewhere between this charmingly uncomplicated, reliable, mechanical aid and the expensive and touchy devices which work so perfectly in the business shows, lies the burden of this article. To put it more in the style of *Library Trends,* the machines and devices which are to be discussed here are those which may be regarded as simple extensions of the hand or mind and which are designed to speed some operation or to relieve muscular strain, but not those intended to alter substantially the methods commonly used in libraries.

The common aim in introducing tools or machines into almost any process is to reduce the time or energy required to perform some operation or to produce a more uniformly satisfactory result. To stick to this rule in the application of what may be referred to as "gadgets" is sometimes difficult; many of these devices have a kind of fascination for some librarians which occasionally obscures the true economics of their application. The warning, then, which must be held up at all times is this: first, can a new method (or mere elimination of the old) do away entirely with the need for the operation to which the machine is being applied; and, second, if the work must be performed, and if the result is equally satisfactory using the machine, is the unit cost actually lower. Upkeep of the device and personnel training needs, related to its use, incidentally, are factors which occasionally are overlooked in computing costs. Still another danger of the indiscriminate use of mechanical miscellanea is that work may actually be created for them. For example, headings may be efficiently erased,

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using an electric eraser, from cards which might more economically be destroyed and replaced by new stock. With these dire warnings, however, it often is the case that the use of gadgets can both be economical of money and saving of human dignity. A shipping room, for example, which is not provided with hand trucks (perhaps even fork-lift trucks, if the loads are heavy enough), a well laid-out work space, and such conveniences as tying machines can be the scene of needless toil and sweat, besides being more expensive in terms of personnel time than is justifiable.

The popularity of gadgets is attested to by the space allotted to them in such professional journals as the *A.L.A. Bulletin*, the *Library Journal* and *PNLA Quarterly* in the form of regular columns or departments and of articles proclaiming the success of their various applications. A few examples of the types of items described briefly in the *PNLA Quarterly* for January 1956 are: visible files, copying machines, paper cutter, copy follower, and routing forms. Often these are already in use in libraries, but the wide range of materials listed shows the extent to which librarians search for things which may speed their work.

Relatively few devices of the type to be mentioned here have been developed specifically for library use. Meredith Bloss[1] made the suggestion that the American Library Association Committee on Library Equipment and Appliances ". . . sponsor or undertake to arrange a management study of library operations. This . . . would be an extensive, searching study by an industrial management firm of all library routines and processes, and including the formulation or design of whatever methods and machines would be necessary to bring the technical processes of the library to a high level of economy and efficiency." So far as is known by the present writer, this suggestion has not resulted in positive action. Perhaps the most serious obstacle in the way of the development of machines for library use is that the market for them is severely limited in comparison to that for devices to be used in general office work. The probability is that, for the most part, adaptation of business equipment will continue to be the rule and that the "library-oriented" gadget will be the exception. For this reason, journals such as *American Business, Office Management* and *The Office Economist* should be consulted as sources of information on inexpensive time-savers in addition to the library periodicals mentioned above. A few hours spent in browsing through a well-stocked stationery and office supply store often will be productive of ideas concerning new devices and supplies.

Gadgets: Miscellanea, But Not All Trivia

To attempt even a relatively complete list of the gadgets which have been used in libraries would probably consume more time than is warranted. Furthermore, such a list would undoubtedly contain many applications and adaptations suited to some situation not generally found; the value of the gadget in the library is often apart from its use in its primary market. However, it may be useful to cull from the literature a few samples to show the diversity of devices which have found a place in the library. F. J. Reynolds [2] listed a variety of office machines—the subject of another article in this issue—but also referred to the following: dry-mounting equipment for pictures, powered paper cutter, automatic folding machine, electric paper drill, vacuum cleaner, and power mower (with snowplow attachment). S. W. Smith [3] described the Pot-Devin Marginal Gluer and Quik-Print (a machine used in stationery stores to print names on wallets). In regard to the former device, Smith indicated that it had a variety of such practical uses as ". . . pasting date-due slips, pockets and blurbs in books. From 225 to 250 books per hour can be processed by a high-school girl, and the work is superior in quality to that done by hand. Such a machine will pay for itself quickly in most libraries of any size." His application of the Quik-Print device is especially interesting in demonstrating the imagination which leads to the adaptation for library purposes of machinery designed for specific commercial uses. In the St. Louis County Library, this gadget is used in embossing the author's name, the title of the book and the class number where necessary. The class numbers are embossed on strips of leather in various colors, twenty to twenty-five of the same number at a time. The labels are then stored and cut when needed.

One of the most novel devices used in libraries is described by Charlton Hinman.[4] A collating machine in the Houghton Library is employed in ". . . the process of comparing documents that are—or *should* be—identical." The author goes on to describe the machine: "Its essential purpose is to facilitate the very accurate and detailed comparison of generally identical documents, such as the corresponding pages of two different copies of the same edition of a given book that are presumed to be identical—or, conversely, that are for some reason suspected of *not* being precisely the same." A better example of the fact that only the imagination of the librarian is the limiting factor in the use of gadgets in their work could hardly be found.

The use of forms, such as multiple copy order slips, postal cards on which the name and address and the message are typed on the same

side, marginal-punched and machine-sorted cards and pre-gummed labels, has increased rapidly in libraries as well as in business administration. Savings can often be made through the pre-printing of information, the consolidation of several typing operations, or the printing of large numbers of stickers instead of typing or hand-lettering them. Firms which sell business systems are probably the best source of information on this type of labor savers. The uncontrolled proliferation of forms, however, can result in loss of time and involved procedures. "Formitis" may be compared to such a disease as pernicious anemia, in which the victim soon "passes on" if he does not maintain the upper hand, but enjoys a long and sometimes happier life if he does.

With the thought that a review of the gadgets used in one library might serve to illustrate the variety of devices available, a brief survey was made by the author in the California State Library. The following list resulted.

Devices designed for library use: electric eraser, fine computer, card sorter, heated stylus, card holding platens.

Standard household tools and machines: sewing machine, pressing iron, vacuum cleaner (heavy-duty model), one-quarter inch electric drill, knife and scissor sharpener.

Bindery equipment: saddle stapler, powered paper cutter, powered paper drill, book finisher's pallet, and the usual array of clamps, presses, weights, brass-bound boards, and glue-pots.

Warehousing or shipping-room equipment: freight trucks of several descriptions, package tying machine, scales with dials which read directly the amount of postage required as well as the weight, wire packaging device, gummed paper holder.

General office devices: collating rack, numbering machine, mimeoscope, lettering guides, copyholders of several kinds, rotary desk files.

Miscellaneous: wheeled market basket, grommet set, eyelet machine, film viewer.

Forms: multiple-copy order slip, "buck" slip for routing mail, marginal-punched charge cards, pre-printed forms for use in recommending books for purchase.

In addition to the devices and pieces of equipment named, several work stations in the library show that considerable thought has been given to arrangement of gadgets so that the work in which they are used may be performed in a consistent and logical flow. Several local improvisations, such as a slanting board on which newspapers are collated before being filmed, tables to which casters have been

attached, and bins and cupboards arranged for special supplies were evident. Innumerable small items—staple removers, gummed paper moisteners, hand tools, for example—are used in such a variety of ways as to defy counting or description.

The use of novel techniques and strange devices in libraries is, the author found, not limited to association with the modern age of electronic marvels. Commenting on some of the methods of record-keeping in California libraries of some years ago, Susan Smith[5] humorously described one means of keeping track of circulation as follows: "A sloping board with a hole at the top rested on the desk. Different colored marbles to represent the various classes, fiction, history, biography, literature, etc. were dropped into the hole as each book was issued and the take counted the next morning. A resourceful librarian could make quite a game of this." With such a precedent, the predilection of many librarians to seek new methods and machines seems entirely fitting.

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Charging Machines

HELEN T. GEER

COMPARATIVELY SPEAKING, the development of the use of charging machines in libraries has been a slow process. It took many years before librarians themselves were aware of the possibilities of their use in circulation procedures, although in some instances, especially in the college and university field, many office routines in these institutions had been mechanized with satisfactory results. It was only when library administrators realized that machines could not only speed up the charging process and reduce some of the clerical work involved, but also pay for themselves through the resultant saving in staff time and salaries that they began to experiment seriously with their use. This in turn has led equipment manufacturers to develop charging machines which have met at least some of the requirements laid down by librarians.

Although it was not until the late 1920's that any charging machine was put on the market, it is interesting to note that librarians began to explore the possibilities of mechanized circulation procedures as early as 1900. It was in this year that E. W. Gaillard of the New York Public Library constructed a machine for this purpose at a cost of $3,500, but it proved to be unsuitable.[1] The mechanization of charging routines seemed to be almost forgotten after the failure of this experiment, probably due to the introduction in public libraries of the Newark system of book charging which, because of its simpler routines, was a marked improvement over the Browne system generally found in libraries prior to this time.

However, in the late 1920's G. F. Bowerman, librarian of the District of Columbia Public Library, appealed to the U.S. Bureau of Efficiency for assistance in finding a machine, simply constructed and operated, and low enough in cost to be of use to both small and large public libraries. Various companies submitted models, but it was not until 1927 that the Dickman Book Charger, manufactured by the Library

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Efficiency Corporation was chosen as the one which met all specifications, including a reasonable operational cost. This is a manually operated machine which stamps on the book card the date from a special plate inserted in one side and the borrower's number from the borrower's number plate attached to his card, placed in the other side of the machine. Many large public libraries installed the Dickman Book Charger and found it to be satisfactory for circulation procedures, especially since none of the routines involved in the Newark or Detroit self charging systems, then in use, needed to be changed.[2] Despite the inconvenience caused by the fact that adoption of the new system required the reregistering of all borrowers, since each had to be provided with the new borrower's card equipped with the number plate, librarians and patrons alike felt that libraries were now being run more efficiently. The machine, which was simple to operate, produced accurate, legible records, saved staff time and supply costs, and suggested to administrators the possibility of further separating clerical from professional duties, thus making available more time for the librarian to give advisory help to library patrons. This last factor is of course, a primary advantage of all good machines.

Although the Dickman Book Charger was used in many large public library systems in the 1930's, it is not in general use today. In 1941 the company which manufactured it, brought out an electrically operated machine,[3] which did not prove to be completely satisfactory, however, and the company itself did not recommend it unqualifiedly. It is quite possible that the Library Efficiency Corporation, now a division of Bro-Dart Industries, will eventually bring out a satisfactory electrical model of the Dickman Book Charger.

The first electrically operated machine used in circulation procedures was the Gaylord Electric-Automatic Book-Charger. This machine, was introduced in both public and college libraries in 1932. Like the Dickman Book Charger, it performs the same routines formerly done by the desk assistant in the Newark charging system, thus making it simple for any library to install. As with the Dickman machine, reregistration of borrowers is necessary because of the special borrower's card equipped with a metal plate embossed with the registration number. Date plates indicating the loan period are also necessary with this machine. The Gaylord machine, which is simple to operate, contains a slot into which the borrower's card is placed, and a chute into which the book card is pushed for recording the transaction. With this procedure the date due and the borrower's number are printed automatically on the book card.[4]

The Gaylord machine offers many advantages to both college and public libraries where it has been widely installed during the past twenty-four years. The accurate and legible records it produces, the simplicity of its operation, the saving in time and supplies, its adaptability to various sizes and types of library, its relatively low cost, and the ease with which it can be installed without changing basic routines, have made the Gaylord charging machine particularly satisfactory for small and medium sized libraries.

The next major development in the field of mechanical charging systems occurred with the introduction of the photographic charger. Its importance lies in the fact that it opened up an entirely new concept of machine charging and the use of a numbered transaction card which served simultaneously as a date due card. By filing these cards by number, after the books in which they have been placed are returned, it is easy to ascertain from the missing numbers which books are overdue. Many charging systems subsequently developed, some of which use machines, have been based on the photographic system.

The idea of using microfilm and photographic paper on which to record each charging transaction was conceived by R. R. Shaw while he was librarian at the Gary Public Library. His first experiment for this purpose was carried on with the Recordak Junior Microfilmer, a product of the Recordak Corporation. This was in 1940. Seven years later, Shaw, who has long been interested in the use of machines for the improvement and simplification of library routines, with the help of the Library Bureau Division of the Remington Rand Corporation, developed the Remington Rand Photocharger which uses photographic paper rather than microfilm on which to record the transaction.[5] Remington Rand has also another machine, called the Film-a-Record, which could be used for circulation purposes, although it has not been adopted as yet by any library.

Recently another photographic machine, using microfilm, has been developed by the Flofilm Division of Diebold, Incorporated, of Norwalk, Connecticut. This machine is known as the Diebold Portable Microfilm Camera and is beginning to be used in public libraries for charging operations.

The Remington Rand Photocharger and the Recordak Junior Microfilmer operate in much the same way. Briefly, the borrower's identification card, the book card, and a prenumbered and predated transaction card, are placed on the copying stage of the machine. When the switch is closed, the complete record is made on either the photographic paper[6] or microfilm[7, 8] depending on the machine used. The

Diebold Portable Microfilm Camera, a small, compact machine, operates somewhat differently. Instead of placing the borrower's identification card, book card, and prenumbered and predated transaction card on a copying stage, these three items are pushed through the microfilm area of the machine until they emerge into a collection tray at the rear.[9]

As libraries gained experience in the use of these photographic chargers, they developed means for simplifying the routines and making the whole operation smoother. Serially numbered punched cards are used frequently with these machines, although a hand numbered 3" x 5" card can also be used. Visible records of one sort or another have helped to handle reserves, always a problem in any transaction card charging system.

In general, photographic charging machines give a complete and permanent record of all books withdrawn from the library. Savings in operations, records, and supplies are effected and the charging and discharging procedures are faster and more accurate as compared with the older type of manual charging methods. The installation of these machines is fairly simple and is accómplished without major changes in supplies. The disadvantages connected with this type of machine are, for the most part, only those that are present in any system using a transaction card for a date due card, such as difficulty in handling reserves and inventory procedures.

Each of the three machines described—Remington Rand Photocharger, Recordak Junior Microfilmer, and Diebold Portable Microfilm Camera—present advantages and disadvantages, which should be weighed carefully by librarians who are considering the purchase of this kind of equipment.[10] The Remington Rand Photocharger, for instance, requires no reading machine, as do the Diebold and Recordak. Although the latter has a built-in reader, most large libraries feel that a second reader is necessary since the first machine is too constantly in use. Changing the film in the Diebold charger is a simple procedure, but more complicated in the other two. Because of its size, the Recordak is felt to place a barrier between the library assistant and the patron, whereas the smaller Remington Rand Photocharger and particularly the Diebold machine are less likely to create this public relations problem. The charging routines are easy to handle in the Recordak and Photocharger, but are apt to be slower with the Diebold machine when a borrower withdraws more than one book. The expense of photographic book chargers is another item to be considered. The Recordak can be rented and a purchase-lease arrange-

ment can be made with Remington Rand, but the Diebold camera and microfilm reader must be purchased. However, its price is not exorbitant.

The Recordak and Photocharger have been used quite extensively in public libraries, whereas the College of Steubenville Library is the only college library which has used a photographic charging machine to date. The Diebold machine, being comparatively new, is perhaps still in the experimental stage so far as libraries are concerned, although installations are constantly being reported.

Closely related to the photographic book charging machine is the Audiocharge, which uses standard office dictating machines. From experiments made in 1948 by S. W. Smith in the St. Louis County Public Library, it was found that of all the dictating machines and tape recorders on the market, the Soundscriber and Gray Audiograph were best suited to the making of charging records.

The charging procedure involved is much the same as with other systems using transaction cards for date-due cards, except that the record of the charge is audible rather than visible. The transaction card number, author and title of the book, and classification number, accession number or copy number, and the reader's name and address, taken from the borrower's card, are dictated into a microphone and recorded on the disc which has been placed on the machine.[11] Special playback equipment is available, thus eliminating any processing of the recording medium for carrying out overdue routines. Each disc can be used several times by having it reprocessed.

Librarians have found the audio-charging machines particularly useful on bookmobiles where they can be operated by means of an inverter with 6 volt electric power systems. On the whole, however, Audio-Chargers have not been popular in libraries, although reports show they are used in some small and medium sized ones.

Another important development in charging machines took place in 1940 when the Montclair, New Jersey Public Library in cooperation with the International Business Machines Corporation installed four IBM machines for the purpose of experimenting with automatic book charging equipment involving the use of punched cards. The experiment has worked exceedingly well in the main library, but the company is still attempting to develop a low cost unit card with smaller capacity for use in branches before putting this system on the market.[12]

The main piece of equipment used in this system is a record control unit, which consists of two slots for the insertion of the punched book card and the punched borrower's identification card, and a keyboard,

which resembles a cash register, wired to a punching machine. When the punched book and borrower's identification cards have been put in the appropriate slots of the record control unit, a key on the keyboard is depressed, thus releasing an electric current which flows through the holes in the cards and is transmitted to the punching unit in order to produce another punched card. This second card gives data from the book and borrower's cards and any other information needed, such as branch from which issued, assistant, date of issue and due date, and the serial number of the transaction. Other phases in the control of the circulation procedures are also mechanized and can be performed by specially trained assistants.

When books are discharged, a return card is reproduced by inserting the book card into the record control unit and depressing a key to indicate the type of transaction. With sorting machines and a collator, the transaction cards are sorted by call number and matched against the basic file of charges; the return card makes it possible for the original card to be pulled from the file; and new loan cards are merged with the basic file. Thus the following new files result: a new and up-to-date file of books on loan; a file of return cards; and a file of loan cards matching these return cards.

Various kinds of information can be ascertained by sorting and resorting the return cards and the displaced loan cards—such as statistical data, control of fines and charges, and conducting of circulation studies. A punched tracer card can be made for handling reserves.[13] This automatic book charging equipment, as worked out by the International Business Machines and the Montclair Public Library, presents many possibilities in circulation procedures.

Out of this experiment at Montclair, the International Business Machines Corporation, in cooperation with the Detroit Public Library and the Stockton and San Joaquin County (California) Free Library, developed a simpler method for charging out books with IBM machines. This is known as the IBM Circulation Control System.[14] A time stamping machine is used for stamping the transaction number, date due, and name and number of the branch issuing the book on a loan slip previously filled out by the borrower. The transaction cards are sorted and filed by branch name or number in a card sorter. By using a master deck of numbered cards, the collator can sort out the transaction cards that represent overdue books. A reproduction punch is used for punching new cards and a card interpreter for translating into print the information punched on the cards.

Much the same IBM equipment, with the addition of the Alphabetic

Duplicating Key Punch, are found in large college and university libraries using punched transaction and call cards. The same procedures for sorting as described above are used with the collator and sorter. Date due and special charges are first punched on a pattern card by the Alphabetic Duplicating Key Punch and can then be duplicated on all call cards.

Except in the case of the time stamping machine, assistants must be specially trained to run these machines. This IBM equipment, however, can do many routines, such as filing and sorting, formerly done by hand, and produce many kinds of information which formerly took many hours of study and handling of cards.

IBM equipment utilizing punched cards is best suited to large university libraries which necessarily have large circulations. The endless possibilities for punching various types of information on the cards and the sharing of these machines with other departments of the institution have made it possible for many university libraries to purchase this expensive equipment. In the public library field, probably in only the very large institutions could the purchase of these machines be justified. However, it is possible for the routines done on the expensive machines to be performed at a local IBM office. It is interesting to note that the two public libraries in which IBM equipment is used—Detroit and Stockton—vary greatly in size of circulation, but can still use the same machines for charging procedures. Detroit circulates over four million books per year, whereas Stockton lends approximately six hundred thousand in the same period.

The McBee Keysort system is another punched card system applied by college and university libraries to circulation procedures. A hand-slotting punch or foot groover is used to punch date due and special charges on McBee Keysort call cards and book cards. McBee Keysort punched cards are sorted by means of a special sorting needle, called a "tumbler." The Selective Sorter, holding one or more needles, can be used for the same process, by selecting one or more classifications from a group of marginal punched cards.[15] The cost of McBee equipment and supplies is relatively low as compared to IBM machines. The equipment consists of a punch and a sorting needle; maintenance costs are negligible, and no trained personnel is needed. Reports show that an increasing number of college and university libraries are using McBee equipment with punched cards for circulation procedures.

Mention should be made of the innumerable punches, numbering machines and miscellaneous items that can be used either in addition to the machines mentioned or in place of them. These are used

especially in connection with punched cards and can simplify and perform more quickly the routines involved in the various charging systems. For instance, an alignment block is helpful in sorting McBee Keysort cards with a needle; a film rewind device is available for use in connection with the Remington Rand Photocharger; numbering machines similar to the kind used for accessioning purposes will facilitate procedures; and a hand punch is a convenient tool for punching McBee Keysort cards.

Of interest among machines applicable to circulation routines is also the Photoclerk, which is a copying machine designed by Shaw and built by the Remington Rand Corporation. Based on the principles involved in the Photocharger, this machine, as it was used in the libraries cooperating in an experiment from 1950 to 1952, was found to cut costs considerably in many circulation routines. Of particular interest were those in which the Photoclerk was used to prepare overdue notices, and in handling special charges and interlibrary loan requests.[16]

Within the past year three companies have experimented with still different types of machines. The Addressograph-Multigraph Corporation of Cleveland has been investigating the possibility of adapting the credit plate, as used in department stores with charge accounts, to library circulation procedures. This company now has available the Bookamatic charging system, which uses a plastic book card embossed with the name of the author, title and classification number, a plastic borrower's identification card embossed with his name and address, and a charge imprinter, a machine similar to that used in department stores but having a larger printing area. The plastic book and borrower's cards, which have the added feature of being permanent, are embossed in the Graphotype machine, manufactured by the Addressograph-Multigraph Company. The keyboard on this machine is that of a standard typewriter, with the usual space bar, and operates in the same way. When a key is pressed, the embossing is accomplished automatically by electric power. The company installed the Bookamatic charging system in the Midland, Michigan Public Library as a pilot project during the summer of 1956.[17]

In the operation of this system a punched date due card and "expendable" transaction cards, numbered consecutively are used. When a book is charged out, the plastic embossed book card is placed in the imprinter space with the borrower's plastic embossed identification card above it. The date due and transaction cards are pulled from the file. The latter is placed over the two cards already on the

imprinter and by pushing the handle of the machine down, the author, title and classification number of the book, and the name and address of the borrower are printed on the transaction card. The transaction card, which later serves as an overdue notice to be inserted in a window envelope, is turned over for printing on the other side. The plastic book card and punched date due card are placed in the book pocket; and the identification card is returned to the borrower, thus ending the charging out process.

Particularly good features of this new equipment are the compact, sturdy construction of the machine, the simplicity of its operation, and the convenience of using the transaction card as an overdue notice and its top portion as a means of locating the charge in the circulation file. Altogether, the Bookamatic charging machine appears to hold considerable promise for all sizes and types of libraries.

At the American Library Association conference in 1956, the Bro-Dart Industries showed for the first time another type of machine to be used for circulation purposes. This machine, now called "Brodac," uses a special heat and infra-red sensitive paper on which the transaction is printed. Additional copies of this transaction also can be made on the machine. This machine is still in the experimental stage, but the company hopes to have it available for sale or rental during the early part of 1957.

During 1955, the Telecomputing Corporation of Burbank, California, experimented with the idea of using some of their punched tape recording devices for circulation procedures.[18] However, the operation seemed both complicated and costly, and recent word from this company indicates that the equipment is no longer available for this purpose and that the experiment has been abandoned.[19]

In tracing the development of charging machines as used in libraries, certain factors and trends stand out as being significant. From the very beginning, the use of these machines was based on the desire to relieve the librarian of necessary clerical duties at the circulation desk, to simplify the routines involved, and to make library operations generally more efficient. The mechanization of charging procedures came at a time when the emphasis on library services was shifting rapidly from those that were essentially clerical and routine in character to those making fuller use of the professional and scholarly skills of librarianship. This shift in emphasis, therefore, played an important part in the mechanization of various routine library operations of which the application of machines to circulation processes is an outstanding example.

Charging Machines

Five charging machines stand out as being particularly significant in the general development of the mechanization of circulation procedures: The Dickman Book Charger, Gaylord Electric-Automatic Book Charging Machine, Photographic Charging Machines (Recordak and Remington Rand Photocharger), IBM Charging Equipment, and the Bookamatic. The Dickman Book Charger, was the pioneer in the field and was popular in many large public library systems, but is seldom seen in libraries today. The Gaylord Electric-Automatic Book Charging Machine was also a pioneer, since it was the first to be operated with electricity. Without necessitating any change in the supplies used in the Newark system, this machine was able to take over circulation routines formerly performed by the desk attendant and has done so successfully in many libraries since its initial introduction in 1932.

Photographic charging machines opened up an entirely new concept for performing circulation routines. With these machines, a file of serially numbered date due cards, serving as transaction cards, were substituted for the file of book cards, arranged by the date due. Making use of this novel idea, a number of manufacturers have developed photographic chargers which are being increasingly used by both college and public libraries in the mechanization of their circulation processes.

IBM equipment, as used in the Montclair, Detroit, and Stockton public library systems, and in some college and university libraries, is of significance in the over-all development of charging machines. Of particular importance are the almost unlimited possibilities for punching all sorts of useful information into the cards used with the machines, and the speed with which the cards can be sorted into various categories. International Business Machines have helped considerably in saving many hours formerly spent in filing and refiling manually the numerous cards comprising large circulation files.

And finally, the Bookamatic, the newest development in the field, is of special importance because of its potential usefulness in all sizes and types of libraries—public, college, school, and special. It is one of the simplest to operate and could be used cooperatively by various offices of the same institution as well as in business establishments of the community. A single charge plate issued to a resident for use at both the library and a local department store, or such a plate issued to a high school or college student which could be used for registration and identification purposes as well as for the withdrawal of books from his public, school, or college library, is not outside the realm of possibilities.

All of the developments mentioned in this article have come within the past thirty years. What more is there to be done in further mechanizing circulation routines or perhaps in improving the machines already in existence? What new charging machines will be developed within the next decade or so?

There are still many problems relating to charging methods for which librarians and manufacturers have not yet found the answers. How can photographic charging be adapted to college and university libraries? Shaw has suggested that the Remington Rand Photocharger can be used effectively in scholarly libraries which first send call slips to the stacks before a search for the desired books are made in the charge files at the loan desk.[20] H. G. Bousfield recommends that college and university librarians should give more thought to the use of transaction cards and to consider even giving up the standard circulation file,[21] which offers the principal obstacle to the use of photographic charging in college libraries.

Can anything be done to handle more easily the reserved book problem in libraries using transaction cards? A number of schemes are now being used, but the failure to find a completely satisfactory solution to this problem continues to be a drawback of all transaction card systems, although many librarians deny its importance.

A welcome improvement on the Gaylord charger would be an automatic counter which would reveal at a glance the total number of books charged out, eliminating thereby the tedious and time consuming special counting of the day's circulation. Another need often suggested is the use of an embossed plate, attached to the borrower's card, giving the name and address of the borrower instead of just his number. The Addressograph-Multigraph Corporation's Bookamatic is already using such a plate. If the Gaylord and Dickman machines could be adapted so as to use an embossed borrower's plate the handling of overdues could be greatly facilitated.

Could the size of the Recordak machine be reduced so as to help minimize the public relations problem sometimes pointed out by librarians? How soon can the IBM equipment as set up in the Montclair Public Library be perfected and made available to libraries generally? Can tape recording devices, perhaps as suggested by the Telecomputing Corporation, be developed for circulation procedures? These are some of the questions which are often asked or come to mind as one thinks about further developments in the mechanization of circulation procedures. The answers will be found through the cooperative efforts of librarians and manufacturers.

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Duplicating Machines

JOHN M. DAWSON

DUPLICATING MACHINES have come to play an increasingly important role in librarianship, as they have in today's civilization generally. As the number of libraries has increased, and as individual libraries have grown into large and complex organizations with staffs so large that oral communication is ineffective, the need for some rapid and inexpensive means of communication between libraries and within libraries has stimulated the use of duplicating machines. Similarly, an expanded concept of library service has led librarians to seek ways to keep their readers informed of new acquisitions, of material available on topics of current interest, and of new services and facilities. At the beginning of the century annual reports, set in type and printed on letterpress, were almost the only publications generally issued by libraries. Today, with fast, efficient, and economical duplicating equipment available, libraries can and do issue publications of many kinds.

Some of the publications issued by libraries are periodical bulletins which, although usually intended primarily as a means of internal communication between the administration and the staff, serve also to keep other libraries abreast of developments which have not yet reached the pages of the library journals. The most notable of these is, of course, the Library of Congress *Information Bulletin*. Even some of the formal journals are prepared on duplicating machines rather than by letterpress, such as many of the bulletins of state library associations and some of more widespread interest, such as *Serial Slants*. Abstract bulletins, bibliographies, lists of current accessions, and reading lists are duplicated freely. The documentalists include the publishing of technical reports among their functions and usually employ duplicating machines rather than letterpress for these. Many library forms are no longer printed but are prepared on duplicating machines. One of the most important and perhaps the most

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general use of duplicating machines in libraries has been and will continue to be for the reproduction of catalog cards. The stiff stock and small size of catalog cards presents some problems in the use of duplicating machines, and, although few duplicators have been produced specifically for catalog card production, librarians have demonstrated a great deal of ingenuity in adapting them to this function.

There are numerous duplicating machines on the market but there are only five basic types: hectograph, spirit process, stencil, relief, and offset. Each type of duplicator has its own peculiar characteristics, each has advantages over the other types for particular applications, and each has limitations. In the following paragraphs these will be presented, together with a brief description of the operations involved.

In the hectograph process, a master is prepared by typing on the master with a ribbon or carbon paper impregnated with an analine dye, or by writing on the master with a pen or pencil containing an analine dye ink or lead. When carbon paper is used, it is used exactly as ordinary carbon paper is used, between two sheets of paper; the carbon copy is the hectograph master. Once prepared, the master is pressed, face down, upon a moistened sheet of gelatin for a brief period during which the dye from the master is transferred to the gelatin. Paper is then pressed down on the gelatin and some of the dye is transferred from the gelatin to the paper and the paper is pulled from the gelatin. Other hectograph duplicators use small sheets of gelatin which are wrapped around a cylinder; with these, paper is fed into the duplicator, pressed into contact with the gelatin and stripped from it as the cylinder revolves.

The spirit process duplicator evolved from the hectograph process and is similar to it in that both make use of the transfer property of dyes. The spirit process master is prepared by typing or writing on a special master sheet placed on top of a dye impregnated carbon sheet used "wrong-side up" so that the carbon faces the verso of the master sheet. As one types, writes, or draws on the face of the master, dye from the carbon is transferred to the verso of the master, producing a mirror image of the text or drawing. The master is then placed, verso out, on the cylinder of the duplicating machine. As the cylinder is revolved paper is drawn into the duplicator, moistened with an alcohol solution and brought in contact with the master, and dye from the master is transferred to the paper.

The Azograph and Chemograph processes are similar to the spirit process in that they involve the use of a "wrong-side-up" carbon which transfers a substance to the verso of the master, and that the master

is placed verso out on the cylinder of the duplicating machine. Here the similarity stops. In the spirit process method, analine dye is transferred from the carbon, while in the Azograph and Chemograph methods the dye is formed only when the chemicals which have been used to moisten the paper come in contact with the substance on the back of the master. Copies made by Azograph are dark blue, those made by Chemograph are black. Since the dye is formed only when the solution is brought in contact with the master in the duplicating machine, these processes obviate the messiness of the spirit process.

All of these processes are relatively inexpensive, both as to the initial expenditure for equipment and for operating supplies, and they are quick and easy to operate. All are essentially short-run methods: from 50 to 100 copies can be produced from a single hectograph master, depending largely on the skill of the operator; 250 to 500 copies can be run from a single spirit process master; and both Chemograph and Azograph will give about 100 copies from one master. There is a tendency for the copies to become lighter and blurred as successive copies are run off, so that the final copies may be quite faint and indistinct. A purple dye is most commonly used with hectograph and spirit process, but other colors are available and several dyes can be used on one master to produce multi-colored copy. Since all dyes are put on one master before any copies are produced, there is no problem of insuring perfect registration of different colors with different masters. Hectograph duplicators are usually manual, but most manufacturers of spirit process duplicators make both manual and electric models, as do the manufacturers of Azograph and Chemograph. Few libraries use these processes for duplicating catalog cards, but they are often used for exchange lists, accessions lists, memoranda, and other ephemeral materials.

In the stencil or mimeograph method of duplication a wax-covered fibrous material is used as the master. The text or drawing to be reproduced is cut into the stencil by typewriter or by a steel stylus, and the typing or drawing cuts through the waxy material on the stencil so that ink can pass through. When the stencil is cut it is wrapped around a perforated drum containing a liquid ink which, as the cylinder is revolved, is forced through the cuts in the stencil onto paper. Several thousand copies can be made from a good stencil. Colored inks are available, but only one color can be printed at one time, so that if several colors are desired a separate stencil must be cut for each color to be used. This, of course, introduces the problems of aligning the

material cut into the stencils, and exact registration of the paper and stencil in the duplicating machine.

Stencil duplicators have been and still are widely used in libraries for many purposes. No other method of duplication has been so widely used in the production of catalog cards, and at one time a stencil duplicator designed especially for this purpose was marketed. This model is no longer made, but libraries have had great success in adapting other models for card reproduction.[1] In addition to catalog cards, libraries use mimeograph to reproduce all kinds of library forms, both for internal and external use, bibliographies, reports, circular letters, news bulletins, and so forth. Both manual and electric models are available from most manufacturers, and some manufacturers make stencil duplicators of postal-card size. One very inexpensive type of stencil duplicator is of postal-card size; it is hand inked, and operates by having the stencil holder rocked over cards.

Addressing machines are not conventionally considered duplicating machines, but the type which uses very small stencils have been used in some public libraries to reproduce catalog cards and book cards for fiction and other short cards,[2, 3] as have those which use embossed metal plates.[4] Both types have also been used to imprint subject and other added entries on catalog cards when it is necessary to prepare many sets of cards. It should be noted that the use of the embossed metal plate type requires the use of embossing equipment.

The most familiar of the relief processes is, of course, the printing press. It is not normally thought of as a duplicating machine in the sense the term is used here, and its operation and products are so completely familiar that it need not be discussed here.

The Multigraph Relief Process uses movable type with a raised printing surface similar to ordinary printing type. The body of the type, however, is considerably shorter than the body of printing type and is grooved to slide into channels on the drum of the Multigraph duplicator. The type comes in tubes in a variety of faces, the most common of which closely resemble that used on typewriters. In its simplest form, the operations involved in Multigraph reproduction are as follows: The text to be reproduced is composed by sliding the desired characters from a stand which holds a font of type into a composing tube until a complete line has been composed. This line of type is then slid from the composing tube into the appropriate groove in the printing cylinder or drum and, by means of special clips, locked into position. In this way all the text to be reproduced is composed and inserted in the cylinder. As the cylinder in the dupli-

cating machine is rotated, the type is brought into contact with a rubber ink roller which deposits ink on the type; as the cylinder continues its rotation, paper is fed into the duplicator and brought in contact with the type. The end product is very similar in appearance to the product of the conventional printing press. A ribbon such as is used on typewriters, but wide enough to cover the drum of the Multigraph, can be obtained and, if this is used instead of printing ink, the Multigraph will produce copies that give the appearance of having been typed. Numerous type styles are available and ink of any color can be used. Multigraph is a long-run method; the cost of type-setting is high, but when thousands of copies are required the per-copy cost is not exorbitant.

Many large libraries have used the Multigraph for the reproduction of catalog cards, but the cost of typesetting for the small number of copies wanted—even when a keyboard typesetting device has been used and the used type sold as junk metal rather than redistributed—has been so high that most of them have abandoned it.

Offset duplicating machines operate on the lithographic principle—that water and grease repel each other. The material to be duplicated is typed, written, or drawn on a master with a special ribbon, pencil, or ink which contains a greasy substance. The master is then put on a cylinder and dampened with a watery solution which is held by the surface of the master except where the greasy writing or drawing repels the water. The master then passes over an ink roller and the greasy image picks up a layer of ink while the moist surface of the remainder of the master repels the ink. The master is brought in contact with a rubber blanket on another cylinder and the ink from the master is transferred to this rubber blanket. As paper is fed into the machine it is pressed against the rubber blanket and the ink from the blanket offsets onto the paper.

Masters of paper, plastic, or metal can be used, depending upon the number of copies used and the quality of reproduction desired. Paper masters are available in different grades, ranging from very short-run for not more than 50 copies to long-run masters which will reproduce about 5,000 copies. Plastic and metal masters will permit even longer runs. Photosensitive masters, also in paper, plastic, and metal can be used to duplicate material already set up. If photosensitive masters are used, a photographic negative of the image to be copied must be made and the sensitized master exposed to this negative in a contact printer. When the sensitized master is developed it can then be used to run off copies by offset. The Library of Congress

uses this method to reprint cards for subscribers when the initial printing is exhausted. Copies of involved line work and of halftones can be reproduced most satisfactorily in this way. Masters of high quality can also be prepared by facsimile or xerography equipment, as discussed below. All offset duplicators are electrically operated. One manufacturer distributes a model which can be used both for offset and relief printing. Models are available which can print both sides of a sheet at one running, or can print two colors on one side in one run.

Offset equipment is considerably more expensive than the hectograph, spirit process, or stencil duplicators, but because of the flexibility and high quality of reproduction possible in offset, it has been widely adopted in libraries as well as in industry. Offset is used for the reproduction of catalog cards, all kinds of bulletins and lists, technical reports, and for publications such as *Serial Slants* and the University of Illinois Library School *Occasional Papers.*

In recent years equipment has been developed for use in conjunction with duplicating equipment which has greatly extended the usefulness and scope of these machines, making it possible to copy on a master text or illustrations for further reproduction without the need for photographic negatives or photosensitized masters.

Facsimile devices reproduce materials on stencils, and offset and spirit masters. The original to be copied is wrapped around a cylindrical drum and a master or stencil is wrapped around another drum. A photoelectric scanner, mounted on a carriage which moves slowly along the length of the drum, scans the original copy as it revolves; a recording device, mounted on the same carriage, traces over the stencil or master on the receiving drum which is revolving at the same rate as the recording drum. When the scanner detects an image on the original an electrical pulse causes the recording device to reproduce the image on the stencil or master. When the scanner has covered all of the original the recording device will have reproduced a facsimile of it on the master. Some facsimile machines are so built that the reproducing device can be located miles away from the scanning device. Since the material to be copied must be mounted on a cylinder, this type of equipment is obviously unsuited for copying pages from books or journals. There is no technical reason why similar devices for scanning flat pages could not be devised; indeed, such a machine was developed for the Atomic Energy Commission.

Xerography, or Xerox, to use the trade name, relates to an electrical copying process in which an aluminum plate covered with a thin

coating of selenium serves as the transfer medium. Selenium is "photoconductive;" that is, it is a conductor of electricity when exposed to light, and a non-conductor when kept in the dark. In the xerographic process, the selenium-covered aluminum plate is given a positive electrical charge and, in a camera unit, exposed to the original to be copied. Where light is reflected from the white surface of the original, the plate is exposed to light and the electric charge flows from the selenium into the aluminum; but where the areas of writing or drawing do not reflect the light, the selenium remains a non-conductor and the charge remains. Thus a pattern of electric charges which is a mirror image of the original remains on the plate. Keeping the plate in the dark, a resinous powder is cascaded over the plate, and particles of this powder are attracted and held by the positive charge on the plate. The master is then placed over the plate and given a positive electric charge, and the positively charged plate attracts and holds the powder from the plate. At this point the powder is held only by the electric charge and any part of the image can be removed if desired. The master is then inserted in a fusing unit and the powder fused permanently to the master. It should be noted that the selenium-aluminum plates can be used hundreds of times. Copies can be made directly on paper, on clear acetate, and on offset or spirit process masters.

With more recent Xerox equipment it is possible to make from six to eight copies directly from an exposed plate on paper, or several copies on paper and the final copy on a master for duplication. The first copies are a dark gray and the last copy black. While the cost of Xerox is too high for use primarily as a copying machine for only a few copies, this development might in some instances make it unnecessary to have a copying machine in addition to Xerox equipment.

The simplest Xerox equipment is a camera unit which neither enlarges nor reduces, a charging-developing unit, and a fuser. Three different types of fusers are now available: a heat fuser for offset masters and paper; a vapor unit, better for paper copies particularly when several direct copies are to be made and essential for preparing copies on acetate sheets; and a special "Flo-set" unit for preparing spirit process masters. The vapor fuser is the most versatile and can be used for paper copies, acetate copies, or offset masters. With the present chemicals used in the vapor fuser there is a tendency to toning in the background of offset masters, but there are indications that new chemicals may eliminate this.

A camera unit which permits enlarging or reducing copy is available; it will copy originals up to 17 inches by 22 inches on an 8½ by 13 inch plate. For this camera unit there is an attachment which will hold panels of visible record panels. A special "tone tray" permits reproduction of halftones and large solid areas. A recent development is a continuous process unit which can enlarge and reproduce from microfilm onto rolls of paper or offset masters.

Xerox-offset reproduction has numerous possibilities for libraries [5] and is used by a number of large libraries for the reproduction of catalog cards,[6, 7] abstract bulletins,[8] and so forth. It is sometimes used to reproduce articles from journals or parts of books for reserve use, and even to reproduce missing pages for insertion in defective copies. Forms, letterheads, and other supplies which were formerly printed on letterpress are often duplicated by Xerox-offset within the library.

Few libraries have begun using duplicating equipment for systems work, where "form" text is preprinted on masters and variable information typed on the master. The Library of Southern Illinois University now uses a preprinted master for its order forms, typing in the author, title, and other variable information. Twelve parts of this form are reproduced, including a purchase order, a report form, and LC card order, an "on order" card for the public catalog, a temporary catalog card when permanent cataloging must be deferred, and so on. The use of preprinted masters eliminates the purchase of printed multiple-part order forms and makes it possible to use parts of paper and card stock in the one form. There are undoubtedly many other such applications that could be developed for libraries.

Discussions of the relative costs of the various types of duplicating equipment are complex and difficult for there are many variable factors to be considered. In general, the order of cost, from least expensive to most expensive is as follows: hectograph or spirit process, mimeograph, offset, facsimile-mimeograph or facsimile-offset, Xerox-offset, and finally, Multigraph. There are many instances where this order would not obtain. An intensive discussion of cost factors in duplication may be found in the International Federation for Documentation *Manual on Document Reproduction and Selection.*[9]

Recent developments in duplicating equipment have greatly enhanced its usefulness, made it easier and simpler to use, vastly more flexible and considerably less expensive. Librarians have already devised ingenious ways of exploiting duplicating machines, and there is every reason to believe that they will continue to do so.

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Photography and the Library

HUBBARD W. BALLOU

BY 1800 THE DEVELOPMENT of the physical and chemical foundations of photography was such that a photograph could have been taken. The camera obscura, which had started about 1000 A.D. as a tent with a small hole in one wall and then became a closed room large enough to walk into, had by 1685 shrunk to a small portable box with lens, no different from the camera to be used to make photographs some 150 years later. In 1725, Johann Schulze established the sensitivity of silver nitrate to light, thus verifying a conjecture that had been current for some time. Further study of the photosensitivity and solubility of the silver salts was carried on during the rest of the century. The fleeting image on the ground glass of the camera now had a sensitive medium to make its beauty a permanent record.

Thomas Wedgewood, son of the famous potter, was producing contact copies of leaves and paintings on glass in 1802. This printing by superposition he considered "useful for making delineations of all such objects as are possessed of a texture partly opaque and partly transparent."[1] But this was not photography in the sense that it captured a visible image from a scene. It was not until 1826 that the first true photograph was taken in France by Joseph Nicéphore Niepce.[2] And, as is usual with most prototypes, it was a rather poor specimen artistically and technically. The year 1839 is usually considered the birthdate of photography. In that year, Louis Jacques Mandé Daguerre, the partner of the deceased Niepce, gave his daguerreotype process to the world, though he had already patented it in England, in return for a pension from the French government. This, the first practical method of photography, was taken up enthusiastically by amateurs and professionals, and reigned supreme for over ten years.

The daguerreotype produced excellent pictures of inanimate objects from the first, and with improvements in the speed of the plate came

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to be used for portraits, some of them of a quality and technique still unsurpassed. Why, then, was photoduplication so long in following? In the first place, the daguerreotype was unsuited to document photography; the image was reversed as in a mirror, difficult to view, incapable of duplication except by rephotographing, produced on an expensive medium, and very sensitive to damage by touch. Furthermore, the library world was not ready for photographic copying. Librarians had not really entered into the spirit of cooperation that is considered to have begun about 1876. At about this same date wood pulp paper was beginning to usurp the place of rag. It would take a few years before this development would make itself noticeable on the floors of library stacks.

In the same year that Daguerre was announcing his process, W. H. F. Talbot proposed his negative-positive technique, using sensitized paper rather than metal plates. Though not capable of producing the fine detail of the daguerreotype, it was easier, cheaper, and capable of yielding duplicate prints. In this sense it is more truly the father of photography as it is known today. Talbot patented his calotype process in 1841.

The next great step in photography was the introduction of the collodion emulsion on glass by F. S. Archer in 1851. Due to its manipulative problems, this process saddled photographers with bulky processing equipment necessary at the point of exposure, but it gave photographers a plate with such an increase in speed that it made possible pictures which could not be taken previously. Though still not an art for the timid or clumsy, photography now began to be taken up in earnest by the serious amateur. This amateur interest, which increased after 1873 when the dry plate made its appearance, was a necessary step before photography could enter the library field in earnest.

In 1844, Talbot published his book, *The Pencil of Nature*. This was the first photographically illustrated book and began a trend that increased from that time on. In it he made public a suggestion that he had considered earlier, that photography was the ideal method for reproducing old texts and other graphic material.[3] The next year Albert Dressel, a German living in Rome, proposed photography as a substitute for the copying of old manuscripts and palimpsests by hand.[4] In 1848 Sevastianof copied a manuscript of 112 pages in a monastery on Mount Athos.[5] In 1856 the University of London considered photography of enough importance to be introduced into the curriculum.[6] By 1860 photography had advanced to the point that

the U. S. Commissioner of Patents considered it as a method for the public reproduction of patent diagrams.[7] In a letter written February 6, 1864, about three months after his address at Gettysburg, Edward Everett stated that, "On this occasion it occurred to me that when a copy of any paper, printed or written, was wanted for a literary, judicial, or artistic purpose, under circumstances that required the assurance of entire accuracy, photography was admirably adapted to secure it."[8] Photoengraving did not appear until about 1856, but it was many years before these first laborious and expensive ink pictures replaced the book illustrated by photographs. Not all of these photographs were processed with the needed permanence; and by 1869 some libraries refused to purchase photographically illustrated books.[9]

By 1877 photography had entered the library to the point that the Bibliothèque Nationale felt it advisable to set aside two darkrooms with running water for the use of readers photographically inclined.[10] About this same time the British Museum began to allow its readers to make their own photographs within its hallowed halls.[11] But in 1884 Richard Garnett, later Keeper of the Printed Books at the British Museum, declared that: "Photographic reproduction has not as yet been regarded as a duty incumbent upon a public library, and has not, accordingly, been provided for out of the public funds."[12] He went on to give examples of the inconveniences met with because the British Museum lacked a photographic service, and suggested an official photographer. Three years later it was reported that such a service had been set up.[13] In 1888, a study of the costs of photoduplication was begun at the Bodleian Library, and on Christmas eve 1890 a price list for this new service was published with the note, "The sums quoted above are given on the assumption that only ordinary trouble will be involved in making the negatives and prints."[14] It would seem that they had the same troubles with their orders that librarians have today.

In 1895, an International Congress on Bibliography was convened which eventually became the permanent institution of the Fédération Internationale de Documentation.[15] This body was responsible for some of the best work done on photoduplication and recently brought out the only manual to attempt a world-wide compilation of information concerning photocopying techniques and equipment.[16] In 1897 Sir Benjamin Stone founded the National Photographic Record Association in England.[17] This association attempted to interest local historical societies in documenting research relating to their areas with photographs. In a sense it was the official beginning of interest in

documentary photography and was to cause an increase in the number of photographs acquired by libraries. In 1905, an International Congress for the Reproduction of Manuscripts, Money and Seals met in Liége, Belgium.[18] In the preceding year, a bad fire had occurred in an old established library at Turin, which misfortune served to focus attention on the problem of preserving unique and valuable records for future use for the benefit of the world of scholarship. One of the loudest voices raised at this meeting was that of Charles Gayley from the University of California, who had come the greatest distance to attend this meeting. He strongly urged a cooperative plan for the photographing of rare manuscripts so that scholars all over the world could gain easy access to them. On his return, he submitted a report of this meeting to the U. S. Commissioner of Education.[19] Among the other recommendations to come out of this congress was the suggestion that darkrooms be established in all libraries.[20] Obviously the small American public library of today was not uppermost in the minds of the European savants.

In any case, these developments show that by the beginning of this century the library world was ready for a good photoduplication process. And so, at this point it might be well to outline the various forms which these processes take:

I. Photographic
    A. Full Size
        1) Projection Photocopy
        2) Contact/Reflex Photocopy
    B. Reduced Size
        1) Miniature Printing
        2) Photoclerk
    C. Microscopic
        1) Microfilm
        2) Micropaper

II. Non-Photographic
    A. Full Size
        1) Contact/Reflex
            a. Diazo
            b. Thermofax
            c. Electrofax

The projection photocopy best known to the general public is the Photostat, which is the trade name for the equipment produced by

a subsidiary of the Eastman Kodak Company. Although not the first on the market,[21] this machine soon took the lead and rapidly became the photoduplication process most commonly found in those libraries which could afford such a service. Essentially the projection photocopy machine is simply a bellows camera expanded four or five times in size, taking a picture on a roll of sensitized paper rather than on a transparent film. In order that the image of the text reproduced be direct-reading, rather than the mirror-image produced by the lens, a prism is placed in front of the camera's lens as shown in Figure One.

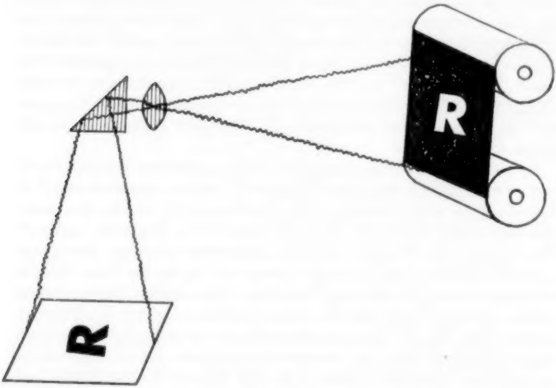

FIGURE 1

Diagram Showing Projection Photocopying (Photostat) Process

This also makes it possible to design the camera so that it is horizontal and yet allows the document being copied to be placed on a horizontal easel at right angles to the camera axis. As the image is projected from the original to the sensitized sheet, there is no contact between the two.

One might ask why the retrogression to sensitized paper occurred when photography had only just advanced in 1889 to light-weight roll film from bulky glass plates? The answer is that film costs about five times as much as paper. The man generally credited with being the

father of the prism photocopy machine is René Graffin,[22] a professor at the Institut Catholique de Paris. At the International Exposition held in Paris in 1900, he entered an exhibit, "Publications syriaques, caractères syriaques; appareil pour la reproduction des manuscripts,"[23] which was awarded a silver medal by the jury of the exposition.[24]

By 1903 it was reported that the John Rylands Library in Manchester, England, was using a "rotary bromide" camera for copying rare materials.[25] This use of a roll of sensitized paper served to make the photocopy camera easier to load, more convenient to operate, and somewhat less expensive to maintain. In 1902, G. C. Beidler of Oklahoma City began the construction of a photocopy machine which he completed two years later in Rochester.[26] There he organized the Rectigraph Company in 1906 which in 1935 became part of the Haloid Company. By 1908 the Clarendon Press at Oxford was reported to be making "Rotographs," and the Graffin process was available at many European libraries.[27] The next year the Commercial Camera Corporation of America, later to become the Photostat Division of Kodak, began operations.

By 1912, American libraries awoke to the possibilities of the Photostat camera. In February the Library of Congress installed one;[28] in May the John Crerar Library got a Cameragraph,[29] and by December the New York Public Library had acquired a Photostat camera.[30] The parade had begun, and soon Photostat cameras, Rectigraph cameras and later the Dexigraph camera of Remington Rand were to be found in many of the larger libraries of this country. The projection photocopy came to be used in advancing library service in all departments of the library,[31] and scholars became accustomed to photocopy reproductions of rare and inaccessible originals. By 1929 it was reported that forty-two libraries in the United States owned and operated "photostat" machines.[32] It is interesting to note that, although an English library was well ahead of any American library in making use of the projection photocopy, by 1949 only eight libraries in England were reported as having such equipment.[33]

The projection photocopy did yeoman service in familiarizing librarians and scholars with the aid they could receive from photography. However, the cameras are large and make necessary the use of ancillary equipment, such as dark-rooms, dryers and trimmers, which take up valuable space. The cameras are also expensive, about a $2,000 minimum, and need to be kept in fairly continuous operation to prove economical. They are, therefore, not the answer for small-scale photocopying operations.

The Contact/Reflex photocopy fills in where the other is impractical. In its simplest form this consists of a sheet of photo-sensitized paper, a plate of transparent material to hold this sheet in contact with the page to be copied, and a light source. When copying an original inscribed on only one side of a rather translucent paper, the contact print can be made. In this case the original is placed over the sensitized sheet, with its back in contact with the emulsion as illustrated in Figure Two. When light is shined through the original, it is held back

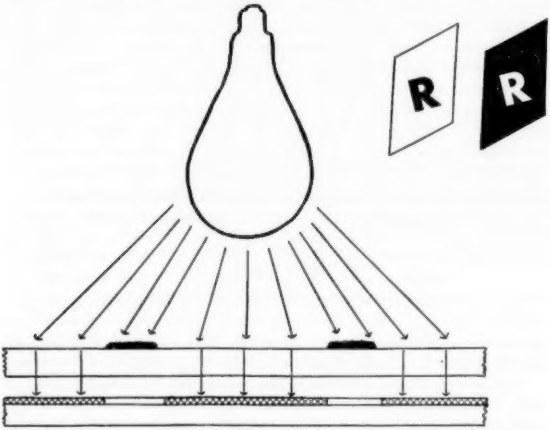

FIGURE 2

Diagram Showing Contact Copying Process

by the more opaque writing, and upon development a readable negative (white text on a black background) is produced. When the text to be copied is on relatively opaque paper, or when text appears on the other side, reflex exposure is used. In this case the sensitized sheet is placed on top of the text with its emulsion in contact with the face of the text as shown by Figure Three. Light is then shined through this sheet and by reflection from the white spaces, and absorption where black text appears, gives the sheet enough exposure upon

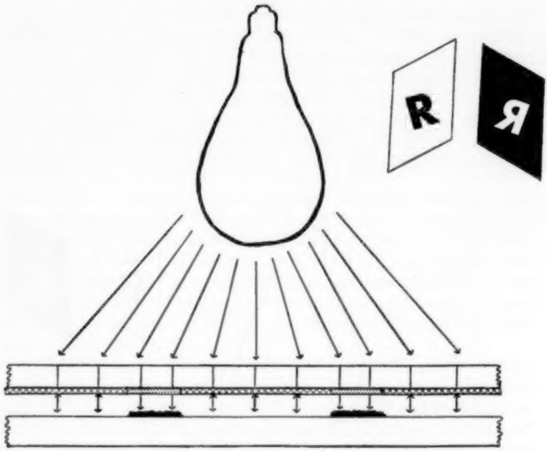

FIGURE 3
Diagram Showing Reflex Copying Process

processing to produce a mirror negative. This negative can then be reprinted to make a final positive which makes possible direct reading.

Contact exposure is essentially the system used by Wedgewood in 1802. Reflectography was first described by Albrecht Breyer, a German medical student in Liége,[34] who reported his discovery to the Brussels Academy of Sciences in 1839, the same year that Daguerre published his process. Breyer's "heliographs" were forgotten in the general excitement, and in 1896 J. Hort Player, an Englishman, rediscovered the process.[35] A number of reports appear in library and photographic literature advocating contact printing, but as most of these suggest impregnating the original with a greasy or waxy medium, they did not meet with much enthusiasm from librarians.

Libraries in Germany and England were using reflectography by 1934[36] but, with a few exceptions, American libraries did not take up this process until after World War II. The equipment that first appeared on the market was usually a rectangular light box with a

hinged cover. The cover served as a pressure plate to hold the document in contact with the sensitized sheet. In order to be able to copy large originals, these light boxes were made so big that soon they reached about the size of a large trunk. With the advent of the tube light source it was possible to design a reflex copier that was cylindrical and allowed the original and copy sheet to be wrapped around the cylinder.[37] This made it possible to produce large copies with a smaller machine.

Until 1948 all copiers available were designed to handle single sheet materials, not pages in bound volumes. In that year F. G. Ludwig, head of the Photographic Service at the Yale University Library, applied for a patent on his Contoura.[38] This piece of equipment, besides being smaller and thus more conveniently transported, was adapted to copying from open volumes. The light box, topped with an inflatable translucent air cushion, served as its own pressure plate. The air cushion was designed to mould the sensitized sheet to the contours of the curved two-page spread. Another attempt to solve the problem of photographing pages in a bound volume is to be found in the German Autophotom K3D.[39] This model has a roof-shaped exposure surface, so that the bound volume and photo-paper can straddle the gable. An even more radical design following the same principle is seen in the patent for a device using a translucent prism to carry light into the tightest gutter of a bound volume.[40]

Most of the box copiers on the market today, though not designed for books, do make a concession for them in that the light surface extends flush with the edge of the box on one side. This allows the volume to be exposed one page at a time and with enough pressure to get good contact without damaging the binding.[41]

Until World War II, contact/reflex processing was by the conventional, and potentially messy, three-stage process common to other methods of photography. The exposed negative had to be put through the developer and fixer and then washed. For a positive copy the negative had to be used for a new exposure which required the same time-consuming wet processing. This process is described in Figure Four. Short cuts in processing saved time but shortened the life of the photocopy. A controlled short cut is to be found in stabilization processing.[42] In this system, the unexposed and undeveloped silver halides are changed chemically into substances that are relatively stable instead of being dissolved and washed out. This shortens the processing time greatly and, when coupled with the porous platen processing system,[43] makes it possible to cut down on space taking

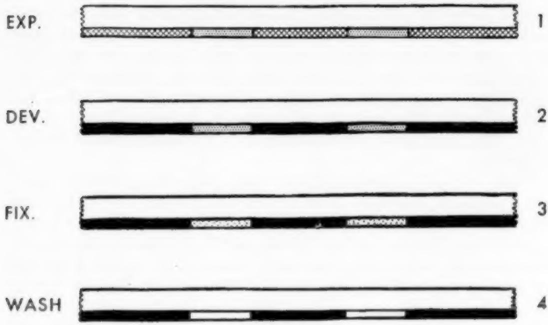

FIGURE 4
Diagram Showing Three-Stage Contact-Reflex Process

darkroom equipment. At best, this method involves a calculated risk, since the finished print fails to satisfy the important requirement of permanence.

During World War II, the German photographic company, Agfa, and the Belgian firm, Gaevert, developed variant forms of one-stage processing which are relatively dry and produce reasonably stable prints.[44] The diffusion-transfer system involves something that is discarded in the older wet method. After the negative has been exposed by either contact or reflex, it is carried through the developing bath and then brought into contact with a positive sheet, as shown in Figure Five. The negative is developed and the unexposed silver halide, corresponding to the black text of the original, transfers to the positive sheet, where it is subsequently developed. After a few seconds of contact, the two sheets are separated and a dry-damp positive is ready for immediate use. The period between 1950 and 1955 may well become known as the silver transfer era because of the number of different office copiers exhibited at business shows during that time. It has been reported that in business offices most of these machines pay for themselves within a year.[45] Most of these copiers, especially the duplex type which combines exposing and developing elements in one piece of equipment, are designed for single-sheet copying and will not work satisfactorily with bound

materials. However, by 1955 some models for book copying were available and one report lists ten libraries in this country using transfer reflex copiers.[46]

In 1952, a variant form of transfer appeared on the market. This was Eastman Kodak's Verifax system.[47] Physically it appears no different from the silver transfer system. However, there is a chemical difference, in that this process depends on gelatine transfer. Exposure and developing selectively hardens (tans) the emulsion of the matrix (negative sheet). On contact with the positive sheet, the matrix gives up a thin layer of gelatine emulsion corresponding to the black portion of the original. This gelatine transferred to the copy sheet becomes the facsimile of the text of the original. Whereas the silver transfer is usually good for only one copy (occasionally two or more, if made under controlled conditions),[48] the gelatine transfer can be used to make six (and it is reported that it will soon be able to make up to twenty) copies from the same matrix. As the matrix is the expensive item, the copy paper costing about the same as typewriting paper, the Verifax copier is most attractive when a number of copies are required. One report suggests that it costs a dollar to copy a letter by retyping, but only eighteen cents if reproduced by this type of photocopier.[49] This would seem to indicate that even though a library did not wish to invest in a photoduplication service based on con-

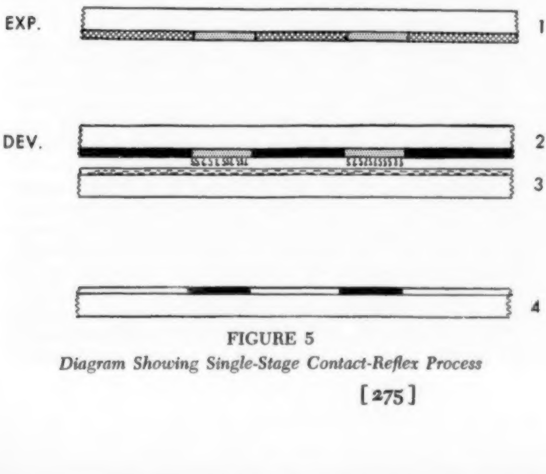

FIGURE 5

Diagram Showing Single-Stage Contact-Reflex Process

tact/reflex photocopying,[50] it might do well to investigate its applications to copying operations in the administrative office of the library.

During the early thirties, before microfilm had established itself in the library, there was consideration of miniature printing to help solve the storage and publication problems facing the librarian. This was to be accomplished by reductions of fifty per cent or more, and thereby bringing about a saving in space without necessitating the use of optical reading machines. This was suggested particularly for scientific publications[51] and theses[52] and was actually attempted with the *New York Times*.[53] A variant of this idea is found in the bound volumes of the Library of Congress catalog or the reprint of the British Museum catalog. But as this technique suffered from most of the inconveniences common to microfilm and did not produce a great space saving or economy, it was not seriously considered for universal application.

Although not an example of miniature printing, the product of the Remington Rand Photoclerk camera may be considered here appropriately. This is essentially a small projection photocopying machine making a full size copy of a 3 x 5 inch original, or a ⅔ reduction to 3 x 5 of an original about 4 x 7 inches. Therefore, it is a somewhat larger version of the Photocharger which is described in another article. In 1952 the American Council of Learned Societies, aided with a grant from the Carnegie Corporation of New York, installed ten of these cameras and ten processors in as many libraries in this country.[54] These libraries were chosen to represent various types and sizes of libraries. They were to apply photoclerical techniques to clerical operations involving the making of copies manually or by typewriter and to report carefully on the comparative costs of the two methods. The results of the experiments, published in 1953, demonstrated the practicability of using the Photoclerk in many clerical operations.[55]

The miniature has always had an appeal to man. The ancient Assyrians are reported to have made micro-writings that were read by means of an enlarging crystal.[56] In 1839, as soon as he heard about Daguerre's process, J. B. Dancer of Liverpool and Manchester made a daguerreotype microcopy of a document at a reduction ratio of 160:1.[57] With the advent of the collodion emulsion in 1851 he had a medium that lent itself ideally to microphotography. Dancer, a maker of optical instruments, improved the technique of microphotography within the next few years, but considered it as little more than a

novelty. In 1853 Sir John Herschel suggested "the publication of concentrated microscopic editions of works of reference—maps, atlases, logarithmic tables, or the concentration for pocket use of private notes and MSS."[58]

In 1906, Robert Goldschmidt and Paul Otlet, troubled by the rising cost of books and the difficulties facing the world of scholarly research, suggested the microphotographic book.[59] The sketch included in their report might be one made today of a microcard. It is 75 x 125 mm. in size, has a brief catalog entry across its top, and includes 72 pages of microtext, most of the current microcards holding only 48 pages. That same year the microphotoscope of Otto Vollbehr of Berlin was announced.[60] This is a small hand viewer which can be used in the dark with an illuminating box. Miniature transparencies of maps were read this way. In 1908, Amandus Johnson began to design his first personal microfilm camera for bibliographical microfilming.[61] The future applications of microphotography had now been suggested, but the world did not yet appear to be ready for it.

Before 1914 the motion picture camera had developed to the point where amateurs were beginning to use it. One amateur who was looking for a way to avoid wasting expensive film through incorrect exposures was Oskar Barnack of the E. Leitz Company, which concern at this time was engaged principally in making microscopes and binoculars.[62] He designed a small camera which used the current 35 mm. movie film but exposed two conventional frames for each picture. This was his exposure meter. The first world war interferred with the development of this camera, but in 1924 the Leitz Company put the Leica camera on the market. Though not the first miniature camera, the Leica was the one which set the pace that caused the 35 mm. idea to be applied to major phases of photography.[63]

In 1925, G. L. McCarthy applied for a patent on a camera for microfilming bank checks which brought him to the attention of the Eastman Kodak Company.[64] As a result, in 1928 the Recordak corporation was formed as a subsidiary of Kodak.[65] That same year R. M. Hessert patented a microfilm camera that could photograph both sides of documents. This patent was assigned to Remington Rand.[66] Therefore, by 1930 the largest photographic company and the largest business and library equipment firm were in the microfilming picture. The United States had reached its first growth and scholars were looking increasingly to European archives for retrospective studies. Their own libraries were becoming filled with the outpourings of faster printing presses. Pulp paper had now had fifty years in which

to begin to crumble. These factors combined to show that the time was ripe for library microfilming.

Although the Library of Congress began microfilming activities in France in 1928,[67] it did not set up a camera at home for another four years.[68] The Leica had a big year in 1931. In that year Yale,[69] Harvard[70] and Chicago Universities[71] and the Huntington Library[72] all began to microfilm with the Leica camera. Two years later an American scholar visited twenty-seven libraries in seven European countries, carrying a Leica.[73] That same year, 1933, the Recordak Corporation began to microfilm newspapers for general purchase.[74] In 1934 the records of the N. R. A. and the A. A. A. were microfilmed, another large-scale project with attendant publicity.[75] A program of the University and Reference Librarians Round Table during the 1935 American Library Association Midwinter Meeting was devoted to the subject of microfilming and supplemented by a small exhibit of microfilm cameras and readers. This was followed by a much more ambitious program the following summer at the Richmond conference during which a symposium on microfilm was held, accompanied by a comprehensive exhibit of microfilm apparatus.[76] This occasion may well be regarded as the official birth of library microfilming.

The response was striking. Papers on microphotography began to appear in all forms of library literature. In 1938 a magazine *The Journal of Documentary Reproduction* under the able editorship of V. D. Tate was launched by the A. L. A. By this time librarians had some twenty-one different microfilm cameras to choose from.[77] True, some of them were not well suited to the job ahead, and others were custom made machines; but time promised to take care of that. In that year University Microfilms, a commercial agency, which was destined to do much to establish microfilm in the scholarly libraries, was founded.[78] The next summer, in 1939, the Columbia School of Library Service offered for the first time a course in microphotography.[79]

Libraries started microfilming with Leica cameras using 35 mm. film. The first commercial film purchased by libraries was of newspapers reproduced on 35 mm. film. The larger image, and consequent smaller reduction ratio, of 35 mm. film fitted their needs better than the 16 mm. film that proved more popular in banks and in other commercial applications. In 1940 Recordak brought out its Microfile line of cameras.[80] The Model D of this family soon became the work-horse for all microfilming not suited to continuous 16 mm. filming.

The father of commercial microfilming reported in 1954 that it was "an industry with an annual volume in excess of an estimated 50 million dollars, built upon some 30,000 equipment installations throughout the country." [81] Early in this present year the president of the National Microfilm Association reported that "There is today no city or town in our country where microfilming equipment or service may not be had." [82] A report published last year announced that out of twenty-nine of the largest research libraries in this country, only eighteen owned microfilm cameras.[83] This is perhaps less an indictment of the libraries than an unspoken compliment for the commercial microfilm service available to libraries.

Microfilming, rather than being the final solution to problems of preservation and storage of library materials (a thought suggested by some enthusiasts in the late thirties) now appears to be considered a stage in a larger program. One large research organization states, ". . . we . . . are convinced that as time goes on it will prove itself most valuable economically in applications where it is used as a working tool." [84] In some new trends microfilm is used as a step towards "hard copy" (enlargement prints); others unitize microfilm by inserting it into sortable cards. The combinations of microfilm with the projection photocopy,[85] microfilm with the reflex copier,[86] and microfilm joined to just about all of the other photoduplication techniques, are putting microfilm to its proper use as just another tool of administration.

Two of the chief criticisms of ribbon microfilm, the principle type used in the U. S., have been its lack of economy for multiple copies, and the difficulty, due to its shape, of gaining access to the information it can store. In 1933, before many librarians had started thinking of microfilm, it was suggested that paper prints made from microfilm might be a better solution to the storage of information.[87] The next year Albert Boni, a publisher who has consistently shown that he is more conversant with library problems than many librarians, began to think about publication in microtext.[88] In 1939 the first public announcement of Microprint and the Readex reader, which had to be designed before the cards could be read, was made.[89] At this time it was felt that the diazo emulsion would be suitable for printing these 6 x 9 inch sheets.[90] But as there was some uncertainty about the stability of the diazo image on paper, it was decided to change to photolithography, which is used today.[91] Wartime shortages halted Boni, and his process did not get going again until 1950.

In the meantime Fremont Rider, then librarian of Wesleyan Uni-

versity, Middletown, Connecticut, had been giving thought to the problem of the growth of the American research library.[92] He gave Readex credit for solving part of the problem, but added two bibliographical suggestions to the micropaper idea. These were that the sheet used be of the standard 3 x 5 inch size, and that it carry cataloging information. Thus the Microcard concept was born. In 1948, the Microcard Foundation was chartered in Wisconsin[93] and *The Microcard Bulletin* began publication. The following year one writer suggested that every town with a population of over 50,000 should have a Microcard reference library.[94] By 1954 there were twenty-three publishers of Microcards, and 1,600 readers had been sold.[95] That same year a program for the publication on Microcards of studies in librarianship[96] came to join an older plan (1938) for the microfilm publication of Ph.D. dissertations.[97]

The Microcard is completely photographic in that the original text is reduced by microfilming and the resultant negative is printed on sheets of photographic paper 3 x 5 inches in size.[98] Eastman Kodak cooperated in the technical development of the process and tested its applications in Kodak's own research organization, so that by 1954 one of their men could report that "Some of the scientists have as many as 15,000 cards on a given subject in their desk drawers, arranged according to their own idea of indexing. . . ."[99] Kodak has just given another push to the micropaper bandwagon by issuing an eight-page summary of what is being published on micropaper.[100]

The printed 6 x 9 inch Microprint sheet and the photographic 3 x 5 inch Microcard have been joined by an offspring that favors each of its parents. It is printed photographically but its size (6½ x 8½ inches) makes it seem closer to the Readex version. This is the Microlex card which carries two hundred pages of text on each side.[101] A reader has been designed for it which, besides being the cheapest micropaper reader, is also the first from which one can readily produce a paper enlargement directly from the card. Whereas Microprints and Microcards are filmed on ribbon microfilm, the Microlex Corporation has developed a novel step-and-repeat camera to film the original on sheet film.[102]

Two criticisms have been levelled at micropaper, the first being that it does not lend itself to the production of minimum editions, the other that the production of micropaper has been limited to four commercial agencies. The advent of the Microstrip[103] and Microtape[104] has been a partial answer. Both of these are processes for making a ribbon paper print from a ribbon negative microfilm. Short

sections of this ribbon can then be pasted, the first by wetting, the second by pressure alone, to cards of any size. They are especially applicable when cumulative records are desired in micropaper form. A recent report suggests micropaper production in single editions, by mounting microfilm strips in acetate jackets and then printing on Kodagraph Microprint paper on demand.[105] This answers both of the criticisms and would appear to justify the statement that "given the proper skills, equipment and supplies, any photographer can make a microcard."[106]

The term photography brings to mind those forms that depend upon the sensitivity of the silver halides to light. An ever increasing amount of photoduplication is being done with other substances. There are even hints that photography, at least industrially, may be achieved eventually with a magnetic tape that has no visible image until the finished picture is produced.[107]

In 1842 Herschel described the use of paper sensitized with certain iron salts for copying by the contact method. He called this the Cyanotype process,[108] which is more commonly called blueprint. This paper was available commercially after about 1881 and was used almost exclusively for architectural and engineering drawings. Its principal drawback is that it needs water for processing, thus being as messy and time-consuming as conventional photography. Also, any process using paper which has to be soaked in water does not give the dimensional stability that engineers need for their plans. Furthermore, the blueprint is a negative process like silver photography.

In the research that attended the development of the analine dye industry, it was discovered that certain nitrogen compounds were light sensitive. Nitrogen is more readily available in nature than iron cyanogens, and certainly more so than silver. These diazo compounds will combine with certain phenolic or amino compounds, called couplers, to form azo dyes with all the hues of the rainbow.[109] These diazo materials can be decomposed by light, especially by ultraviolet, so that they will not couple and form the dye. Therefore, diazo compounds produce positive copies.

It was noted further that if the diazo emulsion is acidic, it will not couple. Therefore, the Ozalid process uses an emulsion that combines diazo and coupler with an acid to keep them from coupling. After exposure, the exposed sheet is passed over ammonia fumes which neutralize the acid and allows the dye to form in those portions that were shielded from light.[110] In the Bruning process the coupler is in

a liquid "developer" which is sponged onto the surface of the sheet after exposure.[111] The Ozalid development is entirely dry, but requires ventilation to exhaust the ammonia fumes. The Bruning machine needs no ventilation, but the prints must be dried after development, which does not wet the body of the paper.

Because of the low sensitivity of the diazo emulsion, the early machines were slow working. With the introduction in 1939 of the high pressure mercury vapor lamp, the exposing time could be speeded up and machines were designed for continuous printing and development.[112] Exposure is given the diazo sheet in contact with the original as the two are carried around the tube light source, much as a pillow case is ironed on an electric mangle.[113] The early versions of these machines looked like upright pianos. Then they shrank to filing case size as they moved from the engineer's drafting room to the business office. Now models are available that are not much bigger than a standard office typewriter.

The big drawback to diazo is that it is economical only for materials that can be printed by the contact process. Where office techniques can be geared to the use of translucent masters, it can be a most gratifying tool. Reflex was attempted with diazo in 1916,[114] but the diazo emulsion is too good a filter to the light that decomposes it. Therefore there is no sensitivity left by the time the rays are reflected by the original being copied.[115] This *aufroll effekt* can be minimized by the use of a dot pattern screen in contact with the emulsion at the time of exposure. A disposable screen which can be removed after exposure and before development was brought out by Van der Grinten in 1945.[116] This Rétocé foil makes it possible to use diazo for reflex copying, but at present it raises the cost of this process to about twice that of photocopy, unless a number of copies are required.

Diazo has been used to a greater extent in libraries in Europe than in this country. One application has been for the publication of an abstracting service.[117] One author has proposed its use for the reproduction of catalog cards and academic dissertations.[118] Some of the reluctance to accepting this idea is no doubt due to doubt as to the permanence of this record. As is true with photocopies, improper processing and careless storage will certainly aggravate deterioration. But libraries are accepting mimeographed materials and carbon copies of typewritten originals.

One application of diazo that will bear watching is its use for the duplication of microfilm.[119] At present this does not have an economic advantage over silver copies, but it appears probable that

it will become cheaper. It does have certain technical advantages and promises to be an excellent way to reproduce cards bearing microfilm inserts. In this application it is economical and fast as well as being a very simple procedure.

So far, all the processes that have been considered have depended on light to record the image of the original. In 1950 a new process was put on the market by the makers of Scotch tape. This was the Thermofax copier, which makes use of heat rather than light.[120] The original and a Thermofax sheet are exposed by the reflex method to a source of infrared radiation. In the older and larger machine, they are exposed under a hinged cover, very much like the early reflex photocopiers. In the new model, these sheets are fed into a slot and carried around the exposing element in the manner of the diazo process. In the larger machine the sheets remain still and the source moves back and forth beneath them.[121]

Infrared is reflected by light-colored objects and absorbed and changed to heat by dark-colored ones. When the infrared rays fall on the inked portions of the original being copied, they are changed

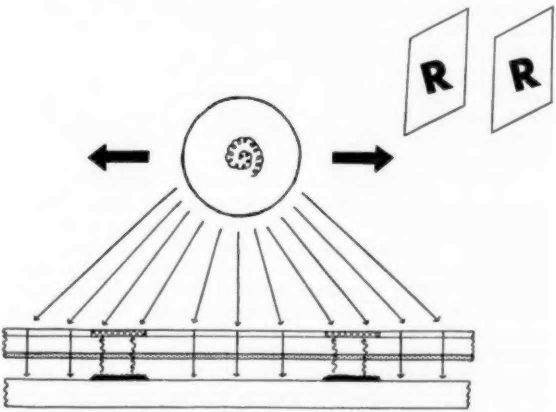

FIGURE 6
Diagram Showing Thermofax Process

to heat and this darkens that portion of the Thermofax sheet which is in contact with it, as diagrammed in Figure Six. Exposure and development are simultaneous and a copy is made at one pass through the machine.

There are a number of objections to the general library use of Thermofax. The smaller "Secretary" model will copy only single-sheet material. The larger "Console" model will work with the thinner journals, but is not yet satisfactory for bound volumes. The paper available at present is very flimsy and has an unappealing beige color. It can be backed up with a second sheet to give it the firmness of either bond or double-weight paper, but this more than doubles the cost of each copy. It works best with carbon-base inks, and does not produce an image with some of the dye-based inks.[122] When these faults are corrected, this process will offer a serious challenge to the other photoduplication processes, as it is the fastest and, for single copies, cheapest of the reflex methods.

Another process that depends on heat is the Kalfax process owned and manufactured by the Kalvar Company. So far this process has been used experimentally on some government projects only, but it is expected that commercial production will begin in July 1956.[123] In use the Kalvar sheet is exposed to light as in conventional photographic equipment and then heated to develop and fix the image. Three advantages are claimed for this process: the elimination of all chemicals necessary for silver halide processing, long shelf life in storage, and lack of sensitivity of the films and papers to ionization radiation. It appears to have applications for microfilm copies and enlargements from microfilm.

A new phase of photography is to be found in two processes that use light but depend on the photosensitivity of an electrostatically charged sheet. The older version is xerography, which is discussed in another article of this issue. One application that is a photographic rather than a duplicating operation, is its use for making enlargement prints on plain paper from microfilm. However, the equipment that is available at the moment is so expensive that it is economical only for operations on the largest scale. It is encouraging to hear a representative of Haloid say that "There is certainly a requirement for a simple, low cost method of reproducing from microfilm to paper for the low volume user, and perhaps this may come in the near future."[124]

The other electrostatic process is Electrofax, developed in 1954

by R.C.A. and available for further applications under license from them.[125] Unlike Xerox, it does not require an expensive metal plate, using instead almost any inexpensive medium that can be coated with a "paint" of zinc oxide in a resin binder. It also does not require that the powder image be transferred to the final support; it is already there. Except for that, it goes through the same basic steps: charging, optical exposure, powder development, and fixing by fusing or solvent vapour methods.

As Electrofax is still in the developmental stage, only theories can be advanced as to the almost boundless applications possible. It has been suggested for office copying machines.[126] Contact prints have been made from microfilm with promising results,[127] and the Navy is trying it out for the continuous enlarging of microfilm.[128] By the time this paper is in print a dozen new suggestions will probably have been made for its use.

What is the shape of things to come? One guess concerning photography during the next thirty years suggests that direct positive photography will take over.[129] This has happened already with the reflex photocopy. The Polaroid-Land camera is the first practical application in black-and-white hand cameras. This has been used for bibliographical note taking,[130] and has been tried successfully with bibliographical photomicrography.[131] It appears likely that it will soon be possible to make lantern slides in a few minutes with this camera.[132] The author can visualize a lecturer making a slide two minutes before his talk, and a member of the audience taking photographic notes[133] from that slide and binding it up and projecting it a few minutes later to an audience that could not get to the first meeting.

In the Bibliofax machine it is evident that the use of microfilm and subsequent enlargement prints do very much the same job as the Photoclerk.[134] In a recent patent a photographic apparatus is described which physically resembles its ancestor, the Photoclerk, but which can expose, develop, and deliver a photocopy in fifteen seconds.[135] Another patent suggests a reflex reproducing process that makes use of luminescent material.[136] The Contoura brought the size of the reflex copier down to slightly larger than a cigar box. This new technique would make it possible to carry the exposing element and a few sheets of photo-paper in a small manila envelope. Exposing from bound volumes would require merely slipping two thin sheets between the pages to be copied.

Two suggestions have been made for a true micro-book. The first

calls for binding Microcards loosely together into a small volume;[137] the second tells of a portable catalog made from microfilm.[138] A card catalog has been microfilmed and short strips of film inserted into acetate Filmsort jackets. These were punched and bound together with rings. Pocket readers have been developed for both microfilm and micropaper. Du Pont has recently announced Cronar, a new thin, tough film base.[139] This will make it possible to produce thinner microfilm and transparent jackets. This brings closer to reality the pocket reference library and reading machine as prophesied by Herschel and Vollbehr.

Another development which may change the pattern of photoduplication as well as the graphic arts is the Huebner "smoke" process.[140] One report suggests the Phototronic reproducer for the rapid enlarging of microfilm.[141] In 1953 it was reported that one fourth of the photographic paper produced in the United States was used for document copying.[142] What with Kalvar, Xerox, and Electrofax, and now "smoke" processing, the demand for silver halide paper may be much smaller by 1963.

Unfortunately, nearly all of the newest and most economical developments are those that involve equipment costing many thousands of dollars. It will take some time before the cost of equipment can be brought to a level which small scale users can afford. For them the best choice is to examine the many combination processes available today, e.g., photocopy with office offset, photocopy with office diazo, diazo with offset, microfilm with offset and diazo, etc. The library administrator of today and especially of tomorrow must be well-versed in the techniques and applications of photography and the graphic arts, if he is to achieve full use of the information stored in his library.[143]

COMPARATIVE COSTS FOR PHOTODUPLICATION
(8½ x 11 Original — Materials only)

Projection Photocopy	5¢
Contact/Reflex Photocopy	
Wet—Contact	6¢
Wet—Reflex	12¢
Silver Transfer—Reflex	10¢
Gelatine Transfer—Reflex (1st copy)	10¢
Gelatine Transfer—Reflex (6th Copy)	2¼¢
Microfilm—35 mm.	½ to 1¢
Diazo	1½¢
Thermofax	5¢

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Projection Photocopy

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Audio-Visual Materials in the Library

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IT IS WITHIN THE IMMEDIATE MEMORY of most librarians when there was little consideration given to the place of audio-visual materials in the library program, since the sole function of the library was construed to be the dissemination of knowledge through the medium of the printed word. Today almost all libraries are making some use of audio-visual materials, in the form of microfilm, filmstrips, 16 mm. films, tape recorders, phonograph records or ceiling projectors. Audio-visual materials are now recognized as another medium of communications, and are incorporated into the service program of most libraries. As the result of intriguing electronic developments, librarians are now standing at the threshold of a new era wherein these devices will assume a far more important function in the operation of the library. The following paragraphs will view the present situation with a brief glance at the already predictable future.

One of the most pronounced trends has been the establishment of audio-visual centers in many libraries, occasionally including both the art and music departments as major subdivisions.

These centers offer an extensive collection of audio-visual catalogs and guides, films, filmstrips, phonograph records, and such facilities as preview booths, listening rooms, tape recorders, opaque projectors and other audio-visual devices.

With the increasing number of states requiring audio-visual instruction as part of the certification requirement, many colleges and universities are offering courses in the field. There is a sharp divergence in thinking on the subject of the library's responsibility in the audio-visual field. One faction holds that the material is not within the library's bailiwick, while those librarians who are engaged in the work feel a natural affinity toward the subject. The audio-visual center as a department of the library has proved most successful in many large operations.

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Librarians without a background in audio-visual devices frequently feel at a loss when faced with the problem of selecting the necessary equipment to establish an audio-visual center. Unfortunately, there are no critical evaluations of audio-visual equipment currently available to serve as a guide. This problem is under consideration by the Audio-Visual Round Table of the American Library Association, and it is hoped that some solution will be forthcoming.

In the interim, interested librarians should participate in the activities of audio-visual groups in order to profit from the experiences of those actively engaged in the field.

In the following discussion of audio-visual equipment a few of the infinite number of possible applications of audio-visual materials will be discussed, along with certain criteria which have been developed to guide in the selection of equipment.

Today 16 mm. film is playing an increasingly important part in the communication of ideas. Each year the major film producers present an increasingly valuable selection of motion picture film to supplement books and other printed materials in the extension of learning. The medium has also been used both by and for libraries to disseminate information concerning the utilization of their services. Public libraries entered the audio-visual field as early as the 1920's, but it was not until 1942 when a substantial number of libraries made film lending one of their regular services. With the impetus provided by the Carnegie Corporation, film circuits were established in Missouri and Ohio, and at the present time over 200 public libraries participate in nineteen separate film circuit programs. In addition, some seventy-two libraries maintain their own independent film lending program.

In order to encourage the use of the films, many libraries provide regularly scheduled film showings, group discussion leaders, and in some instances projector rental service.

A few public libraries, and many universities produce their own film for both personal use and general distribution, and a few industrial libraries are charged with the responsibility of distributing their sponsored films to libraries, schools, and community organizations.

Libraries which do not maintain their own film collections frequently provide referral service using the catalogs of university film bureaus and commercial distributors, or such reference tools as the *Educational Film Guide,* a Wilson publication, and the *Blue Book of Educational Films,* published by *Educational Screen.*

There are a number of 16 mm. projectors available, with no more

than five worthy of serious consideration. The cost of most projectors is competitive and they are of comparable weight. The popular brands are of sturdy construction and generally require little maintenance, although repair facilities should be immediately available in the event of a breakdown. In selecting any equipment, there should be a side-by-side comparison, since it is the only logical way of comparing such factors as ease of operation, procedure for set-up and threading, noise of operation, access to controls, quality of sound reproduction and rewind process. A noisy projector is most disconcerting, and such seldom used features as a clutch for single frame viewing and reverse should not cloud the obvious disadvantages.

All of the popular makes of projectors have provision for the use of microphone, phonograph, and radio tuner through the amplification system. In installations where the machine is to be permanently mounted, it is desirable to provide permanently mounted auxiliary speakers which can be connected to the projector to be used instead of the unit's own speaker which is generally of limited quality.

As with motion picture projectors, there are a number of filmstrip projectors available, but only a few worthy of consideration. Once again, a side-by-side comparison of the products is to be desired. The prospective purchaser can then compare brilliance of image, sturdiness of construction, ease of operation, and amount of heat reaching the surface of the slide or filmstrip. In recent tests, the temperature of slides being projected in two makes of equipment was in excess of 200 degrees. Such heat would tend to do considerable damage to any transparency.

The varying quality of the lenses needs to be observed, with particular attention given to aberrations and true color reproduction. Projectors purchased for library use should be capable of handling both 2 x 2" slides and 35 mm. filmstrip. The ease of shifting from slide to filmstrip operation and the construction of the slide mechanism should be given careful scrutiny.

A great number of the libraries who have entered the audio-visual field have done so through the medium of phonograph records. The revival of interest in phonograph records can be dated from the introduction of the longplay records by the Columbia Record Company in 1948. With increased fidelity, longer, uninterrupted playing time and ease of storage, phonograph records resumed their former position as a principal source of music listening.

This innovation also heralded the beginning of the high fidelity era,

with the new vocabulary of "woofer," "tweeter," "back-loaded horn," and other such phrases.

Some libraries supply records only for circulation, while others provide earphone connections, listening booths or entire rooms devoted to presentation of recorded concerts. In a few situations, the entire library is wired so as to permit a background of pleasant listening throughout the building.

The major number of libraries limit their record collections to long-play discs because of their inherent advantages. Where facilities for record listening are provided, versatile equipment is not required. Any phonograph can be adapted for earphone listening by the addition of inexpensive phone plugs along a line attached to the speaker plug. Such an installation along the edge of a table would permit its use as both a study and listening table.

It is possible for libraries to venture into the high fidelity field without making too great an investment in equipment. Unfortunately there are no regulations regarding the use of the term "high fidelity" in advertising, so the novice should consult the several readable books on the subject, as well as seeking the advice of a reputable dealer. Several of the large electronic distributors have elaborate catalogs which will serve as a guide in equipment selection.

Librarians desiring to obtain a true high fidelity installation are encouraged to assemble the component parts rather than obtain the one-cabinet commercial unit which is high fidelity in name only. No true high fidelity signal is possible when the record turntable and speaker are in the same enclosure. Since the speaker cabinet is as important as the speaker, considerable attention should be given to the selection of both units. The number of speakers in an enclosure is not the sole criteria of quality. Coaxial (woofer and tweeter) or triaxial (woofer, midrange and tweeter) speakers are necessary for quality reproduction.

To preserve the original fidelity of the record one should consider only the diamond needle. Diamond needles are seldom provided as original equipment on phonographs, but must be purchased separately. The osmium or sapphire needles which are provided begin to cause damage after 20 or 65 hours of record playing respectively, while the diamond is good for a minimum of some 800 hours. There is no such thing as a permanent needle, nor is there one needle which will satisfactorily play both standard and microgroove records.

Television is not a completely new medium of communication, the first experiments having been conducted during the latter part of the

nineteenth century. The last decade, however, has witnessed the development of the black and white screen from squint to room size, and the advent of color television. A network of coaxial cables now interconnects the country, permitting a communality of viewing experience. The recent advent of educational television has drawn many libraries into the arena, either through production of their own programs, or by the simple expedient of providing a viewing area. The new facet, educational television, is designed to provide both the in-school and out-of-school viewers with the incentive to either broaden or continue his learning experience. Libraries can encourage these prospective patrons by making the necessary materials available in a convenient and attractive manner.

Closed-circuit television, which is a television network whose viewers are confined to those sets connected to the same coaxial cable, is finding an ever-increasing application at the college level. At the present time classes are conducted by means of this system, with the master teacher shared by a number of viewers, either in the same or in distant institutions. In other situations, experiments which could be viewed only by small groups can now be electronically magnified so that the entire classroom or a series of classrooms may view simultaneously. While these applications of closed-circuit television may have no immediate application to the library, it is conceivable that some future date will see reference work done by television. Visualize, for example, the classroom situation wherein there might arise a question on the definition of a word, the location of a specific area, or the detail of some drawing or picture. Through a coaxial cable, the instructor could request the necessary material from the librarian via the intercom. The class could then view the projected image on the television screen. Perhaps this will not take place tomorrow, but certainly it will happen in the foreseeable future.

At the present time, it is no longer necessary for a class, in order to view a film, to be subject to the confusion of having a projector brought into the classroom. Instead, the film can be projected into the lense of a television camera and viewed wherever desired on the television screen. School architects are already looking forward to the day when auditoriums will be a thing of the past. The guest lecturer will make his appearance in the school's television studio and be viewed by the interested classes in their own rooms.

These are not idle dreams, but reality as of today. The modern videcon television camera is about the size of a shoebox and can be operated by persons with only an elementary knowledge of

television. Ordinary classroom lighting is generally adequate and no expensive fixtures are required. Such television cameras are presently available for some $800.00, or about the cost of two 16 mm. projectors. The coaxial cable needed to connect the camera with the television receiver costs only about seven cents a foot. There is a completely remote television camera available which can be operated by persons outside the room in which the image is being televised. This would facilitate its use in situations where the presence of a cameraman would tend to disrupt the classroom. With this installation it would be possible to observe a student or master teacher without disturbing the normal classroom situation.

The recent announcement by Ampex of a tape recorder which will record both the sound and picture of a television program opens an entirely new vista for the use of these media. When the equipment is available on the commercial market, it will be possible for libraries to have their own collection of television documentaries, special event programs, local productions, and other noteworthy programs.

For the present, however, there is available for the conventional tape recorder a vast collection of pre-recorded tapes covering a wide array of musical selections, plays, lectures, current events, and other materials which should be available from the library.

Many state universities offer a tape recording service, as does the National Tape Repository at Kent University, Kent, Ohio, which provides copies of the desired tapes for a very nominal fee.

To prevent the accidental erasure of these tapes, libraries can acquire tape playbacks, which will play the tape without any danger of erasure. This equipment is less expensive than the conventional tape recorder since it has no recording mechanism.

Few institutions are making full use of the tape recorder. A tape library of the sounds of our time would prove invaluable to historians of some future date. Those who have heard the Edward R. Murrow series *I Can Hear It Now* will recall the pleasure of hearing again recently forgotten events.

Within the foreseeable future, the tape recorder will doubtless replace the phonograph record as the custodian of recorded sound. Tape has many inherent advantages, including the lack of surface noise, ease of storage, fidelity of reproduction, and the facility which permits re-use of the tape when desired.

The usual commercial tape recorder is a dual-track machine capable of handling a 7″ tape at both 3¾″ and 7½″ per second. The faster tape speed gives the increased frequency response desired for recording

musical presentations with their wider tonal range. Professional tape recorders have tape speeds of fifteen and thirty inches per second, which are required to give the ultimate in sound reproduction. There are a number of tape recorders on the market, and the selection should be made with the greatest of care. The equipment should have a smoothly operating tape control mechanism, a fast forward and fast rewind, and an output plug for an external speaker. The machine should be of sturdy construction, with a frequency response of from 50 to 10,000 cycles per second. Although there is a degree of fallacy in most specifications, the sound-to-noise should be no less than 50 decibels with distortion of ± 2 decibels or less. In the purchase of a tape recorder, there is no substitute for quality.

The future of audio-visual devices will be a fascinating one in view of the new developments already in the experimental stage. A new device now being tested will transmit a film via microwave to the classroom in response to a coded signal from the instructor. In the central library, the "film" will be in the form of a small card with an iron oxide surface which will store both the audio and video signals.

With television in color and stored on magnetic tape, films available at the flick of a finger and problems of scheduling, personnel, and human inefficiency minimized, the age of electronic miracles is here. Librarians who would continue to offer their patrons from the full storehouse of knowledge need but to venture into the audio-visual field for all the supplements to the printed page.

Machine Retrieval of Information

MORTIMER TAUBE

THE ROYAL SOCIETY Scientific Information Conference in 1948 included a working party on mechanical indexing. This working party considered the various systems of mechanical selection which were brought to its attention: edge-notched cards; the Batten system; Hollerith and Power-Samas punched card systems; the Samian punched card system; the Rapid Selector; the Univac; Zatocoding; and the combination of punched cards and microphotography.[1]

On the basis of the deliberations of the working party and its recommendations, the Conference concluded "that in the field of subject indexing and selection, designers of apparatus are well ahead of users in the facilities they offer, or plan to offer in the near future. The present need, therefore, is for experiments on a realistic scale using available appliances. . . ."[2]

There are two points which should be especially noted with reference to the considerations and conclusions of the Royal Society Conference on this matter of mechanical selection. In the first place, for almost ten years the list of available systems and appliances has remained constant. Anyone who today undertakes a survey to determine what is available in the field of mechanical selection will find almost the same possibilities considered by the Royal Society Conference in 1948. This seems a curious phenomenon in an age which prides itself on its rapid technological advances. But apparently this stagnation is not something which characterizes the machine designers. The second noteworthy point in the conclusion of the Conference is that the designers of appliances had advanced way beyond the willingness of the librarians, information officers, and documentalists who use manual systems to experiment with and utilize the appliances that are available. The Conference did not conclude that better machines were necessary but that those charged with maintenance of manual systems were lagging in their readiness to utilize

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what was already available to them. To be sure, the Conference recognized that such utilization would be experimental but it thought that such experimentation on a wide scale was justified and necessary because of the prima facie superiority of available mechanical systems to existing manual systems.

Although many who fancy themselves as pioneers and innovators have been impatient of those who seem quite content with the status quo, the author does not recall in the whole literature of documentation a stronger condemnation of a profession than that implied in this conclusion. With machines available, manual methods are still used; and ten years after the Royal Society Conference's condemnation, the same machines are still available and no one or no institution has yet carried out the required experiments on a realistic scale.

If this writer may for a moment take on the unfamiliar role of a defender of the status quo, he would like to point out that the conclusion of the Royal Society Conference was very foggy and not worthy of its own high standards and traditions. It is not enough to call for an experiment; one must also so design an experiment that it will prove what it is supposed to prove. If there is overwhelming theoretical evidence against certain conclusions, experiments are not necessary to reject them. If someone insists on an experiment in the face of such theoretical evidence, he must indicate why he thinks the theoretical considerations are not substantial or conclusive, and how they might be modified by the results of the experiment. Now, R. R. Shaw has calculated that in order to handle the daily reference load of the Library of Congress, 8,333 Univacs would be needed at an investment of close to a billion dollars.[3] What type of experiment is required to prove Shaw wrong? There have been dozens of "experiments" with edge-notched coding systems and with punched-card systems reported in the periodical literature and in the Casey-Perry volume on punched cards.[4] But although the author has searched the literature assiduously and has asked assistance of several expert bibliographers in the field of documentation, he has not succeeded in finding one reference to a controlled experiment which demonstrates the superiority of commercially available mechanical equipment as compared to traditional manual systems. One doesn't need an experiment to determine that cards can be selected from an edge-notched deck or a file of punched cards; one doesn't need an experiment to determine the speed with which a Univac will search a magnetic tape, or a Rapid Selector will search a roll of film.

If Zatocoding, the Batten system, and the Rapid Selector are ex-

cluded from the devices and appliances considered by the Royal Society, the other types of equipment obviously were not developed for the purposes of literature searching or mechanical indexing, but for accounting and computing. Their existence was not an indication that the designers of equipment for literature searching had advanced faster than the willingness of users to test such equipment. These machines having been produced for accounting problems, it remained for the equipment people to demonstrate that their machines could be used for purposes quite alien to those for which they were designed. The burden of proof here is on the designer of equipment not on the information or documentation center.

The other chapters in this book indicate that librarians have not been backward in seeking mechanical solutions for their various problems. Therefore, their failure to use machines for information retrieval is not attributable to their unwillingness to experiment and try new techniques but to the prima facie evidence that the available machines are not satisfactory and cannot perform information retrieval functions as adequately as a card file or a printed catalog.

Librarians have always been aware of the cost of filing cards in an alphabetical or classified array, and of the time required to read through a group of references to select the reference or group of references which will answer any particular problem. The simple fact that edge-notched cards and interior-punched cards can be selected from a random file and at speeds faster than a librarian can read and select cards has confused a great many people.

Actually, an ordered file permits a librarian to make his selection from a small segment of the file; whereas, with random files the total file must be scanned for each selection. Effective sequential information searching devices will be available when it is possible to find any name by a random search of a telephone book as fast as it is possible to find a name by manual search. Further, since there are multiple phone books so that many people can look up names at the same time, any busy library would have to have many machines, each one of which could search the whole catalog as quickly as a reference assistant could find a particular card under a particular heading in an ordered array. This requirement underlies Shaw's conclusion that the Library of Congress would require 8,333 Univacs to match its present service. Mechanized information searching is held back not by the unwillingness to experiment but by the absence of devices which are even remotely suitable to the reference needs of a large and busy library.

It is necessary to emphasize that the inefficiency of sequential searching is a matter of principle because there are those who hope to overcome this inefficiency by spending more and more dollars for data processing equipment with faster and faster rates of search. That is to say, the obvious inadequacy of punched-card equipment for large-scale storage and retrieval systems has turned some minds in the direction of the general purpose digital computer as the solution.

The efficiency of any machine system or device is always measurable in terms of cost. Our railroads changed from steam to diesel because by so doing they raised the efficiency, i.e., lowered the cost of transportation. Similarly, when hand tools are changed to power tools the purpose is always to do more work at less cost. To be sure, the first model of a power tool to replace hand labor may involve a capital expenditure which is not immediately recoverable as lower cost. But even first models must be able to operate more efficiently and at lower cost than the hand labor they are built to replace. It is inconceivable that anyone would ever use a machine which was less efficient than the hand operation for which it was substituted. In fact, this very notion has been responsible for a classic of American cartooning—the Rube Goldberg machine.

All of this is indeed so obvious as to be trite. Yet neglect of just these obvious facts, coupled with unguarded enthusiasm concerning the potentialities of digital computers, has led to a failure to consider the theoretical and practical efficiency of computers as information storage and retrieval devices. This does not mean that those who imaginatively extend the utility of computers from the mathematical problems for which they were devised to the fields of mechanical storage and retrieval systems, do not recognize the need for bigger and better memories with rapid access time and low input and output costs; but there is an absence of a more general concern with the basic question of the suitability of computer design and techniques for the purposes to be served by storage and retrieval systems.

The mechanization of any art of activity, whether it be computation, intelligence analysis, or the storage and retrieval of information, involves the union of two lines of research: the determination of the essential logical pattern of the activity, and the discovery or invention of a mechanism which will be the physical analog of the logical pattern. In the field of computers, there is a special case—the logical pattern of computation, i.e., mathematics, is a highly developed science. Computers were built and used efficiently as soon as the necessary gears, holes, dots, electronic elements, etc., could be

assembled. But the fact that computers found a logical structure ready and waiting has led to serious confusion in other fields. The erroneous assumption was made that computers could be universally applied even to fields whose logic was undeveloped or which did not involve numerical data or the processing of digits. Thus, futile attempts have been made over and over again to force non-numerical and non-digital problems of identification, search, and information recovery, with special logics into the narrow possibilities of digital computers.

Studies of the logic of information storage and retrieval have demonstrated that it is not data processing or rapid addition, subtraction, and multiplication that is required for storage and retrieval systems, but random access, instantaneous recognition, and direct display of any item permanently stored in a static memory. The crucial fact is that not binary digits are input to be computed but terms and logical relations which are appropriate to the storage and retrieval problem.

Suppose in an information center or library that the main concern is the rapid recovery of any item in the library or any fact recorded in any item. Suppose further that costs were not a consideration. The most effective storage and retrieval device for a collection of 1,000,000 reports, documents or other items might then have the following components:

1. One million people each holding and studying a single item.
2. A system of communication connecting the million "storage" points with a central reference bureau or input microphone.
3. A system of facsimile transmission connecting the "storage" points with a central output.

A question sent over the central microphone would start all "storage mechanisms" studying their items and the one holding the desired document could send a copy by facsimile to the central output station located adjacent to the input microphone.

This fanciful supposition has a serious purpose. It depicts exactly what has been done when a million abstract cards are substituted in a catalog for the live storage elements and the searcher then is asked to walk through the catalog system to find the card which suits his purposes; or when cards are brought to the searcher by means of sorting machines, tapes or drums. Certainly the shift from live storage elements to cards or magnetic dots is only significant as a saving in input costs without a proportionate increase in output costs.

Steam shovels and automobiles may have many parts in common—motors, gears, batteries, wheels, etc. But no one would suppose that the way to get better automobiles is to concentrate on designing and building bigger and better steam shovels or vice versa. And the fact that the development of more efficient storage batteries for steam shovels may be, at the same time, the development of more efficient batteries for automobiles is still no argument for the identity of steam shovels and automobiles. Even though steam shovels may be self-propelled and could be used, if efficiency were no object, to carry people from place to place, they are not primarily vehicles for transportation. If all this seems as fanciful as the storage device with one million live storage elements, it is, nevertheless, as reasonable to use a steam shovel for locomotion rather than digging as it is to use a computer as a storage and retrieval device rather than for computation. It can be done but someone driving from Washington to New York in a steam shovel would certainly receive many stares, and similarly the ingenuity of using a good computer as a poor storage and retrieval device should be met with little enthusiasm.

The one factor most responsible for the confusion between the entirely distinct functions of computers and storage and retrieval systems is the common interest in devising ever larger storage devices which will store more information at a lower bit cost.

A computer system processes data which may be fed into the system directly by an operator or indirectly from a memory in order to arrive at certain mathematical quantities. As is manifest from its name, a computer performs an arithmetical computation or a series of them in order to arrive at an arithmetical value. A storage and retrieval system does not perform any arithmetical operations or even logical operations. It searches a memory or storage device to select or identify data in accordance with specific questions put to the system. The form of the question may involve a logical operation, e.g., one can ask for the logical product, PQ. That is, a storage and retrieval machine is not asked to calculate, compute, or derive logical products, but only to find anything stored in the system which can be identified in terms of a logical product. In making identifications for selection, a storage and retrieval machine may use the type of components used by a computer to make computations, that is, reading heads, switches, relays, diodes, holes, magnetic dots, etc. But this similarity of components again should not obscure the essential difference between the two types of systems. Advances in the computer art may certainly

be significant for information systems and vice versa. Thus, the development of the tapedrum "memory" with its large storage capacity is significant for both computers and information systems alike. But the tapedrum is not a computer. In describing the uses of the tapedrum, its developers state: "The tapedrum can be used as an auxiliary memory or storage device for large scale computers."

In short, the similarity of components and subassemblies, the similarity of problems of storage costs, random access times, etc., should not obscure the basically different purposes and functions of computer systems and storage and retrieval systems. The consideration which determines that this is an essential difference with superficial resemblances, rather than essential similarity and superficial differences, is that a highly efficient computer may be a very poor storage and retrieval machine, and a highly efficient storage and retrieval machine may be completely useless as a computer.

Much of the research in the past four years has indicated the possibility that the efficiency of computer systems and storage and retrieval systems varies inversely and now there is reasonable expectation that this relation can some day be quantified and expressed in an equation. It is known, for example, that the efficiency of a collation operation is determined by the ratio of the balance file and the transaction file; that is, if two decks of cards to be collated are of equal size and one deck is evenly distributed throughout the other, then machine collation reaches maximum efficiency. But if one deck contains 1,000,000 cards and the other contains 100, collation becomes highly inefficient. This situation can be generalized into the homely expression, "The less *looking* (searching) and the more operating, the more efficient is a collator or a computer," or, "The smaller the required memory and the larger the number of operations, the more efficient is a computer operation." On the other hand, in a given increment of time a storage and retrieval system should perform the maximum amount of searching and the minimum amount of operating.

There is nothing in what has been said above which in any way denigrates the possibility of efficient storage and retrieval devices. In fact, the building of such machines is certainly a practical possibility. But this practical possibility will never be realized if we continue to emulate the March Hare. Butter isn't any good for a watch even if it's the *best* butter, and digital computers are not storage and retrieval devices even if they can compute in milliseconds.

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Library Trends

Forthcoming numbers are as follows:

January, 1957, *Manuscripts and Archives.* Editor: R. W. G. Vail, Director, The New-York Historical Society.

April, 1957, *Rare Book Libraries and Collections.* Editor: Howard H. Peckham, Director, William L. Clements Library, University of Michigan.

July, 1957, *Current Trends in Circulation.* Editor: Wayne S. Yenawine, Dean of the Library School and Director of Libraries, Syracuse University.

October, 1957, *Research in Librarianship.* Edited by Association of American Library Schools Committee on Research.

The numbers of LIBRARY TRENDS issued prior to the present one dealt successively with college and university libraries, special libraries, school libraries, public libraries, libraries of the United States government, cataloging and classification, scientific management in libraries, the availability of library research materials, personnel administration, services to readers, library associations in the United States and British Commonwealth, acquisitions, national libraries, special materials and services, conservation of library materials, state and provincial libraries in the United States and Canada, and American books abroad.